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EDITOR'S OUTLOOK

Why chemical education? It is gratifying to chemistry teachers that more School Boards and Superintendents are recognizing that chemistry should be incorporated in every high school system of education.

One more war may be necessary before all school authorities become conscious of the fact that chemistry is an essential subject in a complete system of education. Chemistry may not have been necessary when the founders of our country laid down the corner stones of education, but times have changed, and the chemical change has been so rapid during and since the world war that we can only think of the next war with the greatest horror. Yet the horror will be all the greater if we close our eyes to the facts. We should go forward with definite determination that as teachers we shall not be found wanting. The responsibility really rests with us.

Superintendents and School Boards are generally very broadminded people who are more than anxious to place in the curriculum those subjects which are most important and valuable in the preparation of youth for the complex duties and responsibilities of citizenship in a free country. If you can't explain to your superintendent or school board the importance of chemistry in your state or community, I would refer you to the series of books put out by The Chemical Foundation or to such bulletins as have been circulated by Harvard, Wisconsin and other universities.

Directors want facts and will be most interested to know how our great creative science can be used to promote happiness and comfort to the fullest extent in times of peace and how these same developments can be turned over night into a volcano to hurl enemies from our shores.

COLONIAL CHEMISTRY—I. NEW ENGLAND*

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Chemistry began in New England soon after the Pilgrims landed. They evaporated sea water to obtain the salt needed in the household, for preserving fish, and for curing skins, especially beaver skins. They saved the ashes from their fireplaces, leached out the potash, and used the lye, first for washing and soon to make candles and soap. They dug clay from the banks and burned it into pottery and bricks. They burned wood in a crude stove to obtain tar and lampblack. They extracted vegetable dyes from roots, bark and seeds. They tanned skins into leather and made glue from horn.

In the first days the processes were crude and were performed by individuals or families. As settlers increased, coöperation became necessary, and then industries passed into the hands of more skilled men, often imported, or of companies, or even of towns themselves. Gunpowder was always needed, and the three ingredients were eagerly sought, especially saltpeter, which was extracted from excrement. As early as 1642, a law was passed in Massachusetts to compel the people to provide ways of getting niter, and similar measures prevailed even up to the time of the civil war.

As early as 1623, a company erected a salt works at Portsmouth, N. H. In 1638 John Winthrop, Jr., was "given liberty to set up salt works" at Royal Side (near Ipswich), a little later S. Winslow was given a monopoly of salt making "for ten years if he made his way," and in 1648, Winthrop obtained a franchise to make salt and sell it at specified prices. The iron kettles for boiling the salt water in this process were cast at the iron works in Saugus. And so it went on until the Revolutionary War, when the great demand for salt was met in part by importation from Bermuda.

In 1638 glass is first mentioned, and from 1639 to 1659 bottles and hollow ware were made at the glass works in Salem. In 1753 some German glass workers began to make bottles and heavy ware in Braintree. In 1787 a plant for making crown window glass was started in Boston and later its product became famous. The New England Glass Co. was not started until 1817 at East Cambridge, and the famous plant at Sandwich until 1827. Much glass, however, was imported.

Potash and pearlash were made as early as 1631 at Portsmouth, N. H., in connection with a large saw mill. The potash maker followed the lumber man. In 1717 it was stated that a man in one year could cut and burn enough wood to make 8 tons of potash worth from £ 13 to £ 20 a ton. Monopolies were granted. Kettles were cast from iron made from Salisbury (Mass.) iron ore. It was claimed that over 30 tons could be made in

* Part of a paper read at the Eighty-Sixth Meeting of the New England Association of Chemistry Teachers, Malden, Mass., March 15, 1924.

a single kettle, before the kettle wore out. Potash was in demand for soap making as early as 1767.

The first paper mill in New England was started in Dorchester, Mass., in 1728, and in 1760 another was opened in Milton. From these two mills there has grown up a New England industry of vast size.

The colonists noted the deposits of bog iron ore in the swamps and early began to make iron. In 1644 John Winthrop, Jr., began to build an iron works in Saugus (Lynn), having previously gone to England and formed "The Company of Undertakers for the Iron Works," with a capital of £1,000. The next year he made iron, and three years later the output was seven tons a week. The first Superintendent was Joseph Jenkes, who on May 14, 1646, received for a water wheel which he designed the first patent granted on the continent of North America. Jenkes was also the inventor of the American scythe. In the Lynn Public Library is an iron kettle which was made by Jenkes in a clay mould, and it is said to be the first iron casting produced in America from local ore. The dies for the Pine Tree shilling, one of the first American silver coins, were made at the Saugus Iron Works by Esther Jenkes, the wife of the Superintendent. Forty years later (1683) the plant was closed, but it laid the foundations of the iron industry in the United States. The plant at Lynn was followed soon after its establishment by works at Braintree, and other places. And during the next hundred years Massachusetts led the colonies in the iron industry.

In 1658 the younger Winthrop and some associates founded an iron works near New Haven, Conn., and shortly afterward works were built in Rhode Island. Iron was not made in Vermont until 1775, and the famous Champlain district was not opened until 1801.

Most of the early New England iron works were bloomaries, although there were some blast furnaces making castings. The iron made in the bloomaries was wrought iron. In 1784 there were seventy-six iron works in Massachusetts, but many of them were small.

Massachusetts iron was made from the bog ore obtained from swamps, lakes, and ponds. The ore together with shells from the neighboring sea coast was heated in charcoal forges. Some of these early works were abandoned because of the exhaustion of the adjacent supply of wood. In 1804 one of these furnaces, known as the Federal furnace, was declared by its owner to be the finest furnace known. He stated that it had two bellows 22 feet long by 4 feet wide, which were operated by a water wheel 25 feet in diameter. It was at that time chiefly depending upon bog ore brought by vessel from Egg Harbor, N. J. This ore, having thirty to forty per cent iron, cost $6.50 per ton delivered. Local bog ore yielded from twenty to thirty per cent, and cost $6 at the furnace, while a poor grade of bog ore, yielding but eighteen per cent, was bought by some forges at $4 per ton delivered.

About 1750 a new iron field was opened in the western part of Massachusetts, in the Berkshire Hills, and in 1765 there was a famous furnace here 28 feet in height. Adjoining the Berkshire region was Litchfield County, Conn., which began to produce iron about the same time, and for a century was a famous iron district. A well-known furnace here required three tons of ore and 250 bushels of charcoal to make a ton of iron, and made $2^1/_2$ tons of iron per day. In 1800 this county had 50 bloomary forges and throughout the middle and latter part of the eighteenth century this type of iron works was very common upon the stream flowing into Long Island Sound from the north.

The first man who devoted much time to chemistry in America was John Winthrop, Jr. He was the oldest son of John Winthrop, the second governor of Massachusetts. He was born in England in 1606, came to New England in 1631, and died in Boston in 1676. He was buried in the same tomb with his father in the grounds of King's Chapel. A few months after his arrival he began to receive from England chemicals and apparatus for the starting of a laboratory.

It is remarkable what Winthrop attempted to do in the establishment of chemical industries in the New England colonies. He was interested in the production of salt, iron, glass, potash, tar, black lead, saltpeter, copper, alum, and other chemicals. He read papers upon some of these industries before the Royal Society (during a trip to England), of which he was a member, and these are the first contributions to be made by an American chemist before a scientific association.[1]

As early as 1636, upon his return from a sojourn in Connecticut, he began the development of the mineral resources of Massachusetts and the building of salt works. In 1643 he established iron works at Lynn and Braintree with workmen and machinery brought from England. He also started a primitive dyestuff industry, and with his uncle, Emanuel Downing made what were probably the first experiments upon the manufacture of indigo within the present border of the United States. Winthrop had a clear idea of the importance of saltpeter manufacture as a basic protective industry. Through his influence, in 1642 the General Court of Massachusetts passed an order to the effect that every plantation within the colony should erect a house within one-half year next coming to make saltpeter. Winthrop had a library of over one thousand volumes. Many of these are still in existence and may be examined at the rooms of the Massachusetts Historical Society where his portrait adorns the walls.

The chemical industries just described continued to grow. Other industries were added, especially those connected with textiles, leather, glass, paper, iron and steel, paint, materials of construction, distilling, printing, shipping, and commerce.

[1] See article by C. A. Browne, *J. of Ind. Eng. Chem.*, **14**, 1066 (1922).

For several years preceding the war, however, many industries were taxed or legislated out of existence by the mother country. Impending war, too, necessitated concentration on the manufacture of powder, cannon, small arms, clothing, etc. Men were taken away from the industries and plants became useless from inaction or lack of repairs. Money also was scarce. This lapse continued long after the war.

A CENTURY OLD CHEMISTRY NOTEBOOK

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There is in the Library of Princeton University a notebook on chemistry which belonged to John Eager Howard, Jr., of Baltimore. Howard was a member of the class of 1806, and was a son of General Howard, who served throughout the Revolutionary War, and received a medal from Congress for his valor at Cowpens, January 17, 1781. The younger Howard, like his distinguished father, was at one time a member of Congress.

This chemistry notebook is beautifully written and is evidently a transcript of the systematic lectures on chemistry delivered in Nassau Hall by Dr. John Maclean, who came from Glasgow University to Princeton in 1795. In the early summer of that year Dr. Maclean delivered in Nassau Hall a short course of lectures on chemistry, which made a favorable impression. On October 1, 1795, he was elected professor of chemistry and natural history, but the name of the chair was subsequently changed to "mathematics, natural philosophy and chemistry."

In 1797 his salary was 250 pounds ($666.66) per annum; and it was "ordered that chemistry and natural history be taught as branches of natural philosophy." The instruction in these branches was given only to juniors and seniors. Dr. Maclean taught at Princeton until 1812; for several years his salary was $1250 a year, together with the use of a college house.

Benjamin Silliman, M.D., the first professor of chemistry in Yale College, left in his diary the following statement:

"At this celebrated seat of learning (Princeton), an eminent gentleman, Dr. John Maclean, resided as professor of chemistry.....I early attained an introduction to him by correspondence, and he favored me with a list of books for the promotion of my studies.....I also passed a few days with Dr. Maclean in my different travels to and from Philadelphia, and obtained from him a general insight into my future occupation, inspected his library and apparatus, and obtained his advice respecting many things. Dr. Maclean was a man of brilliant mind, with all the acuteness of his native Scotland; a sparkling wit gave variety to his conversation.

I regard him as my earliest master in chemistry and Princeton as my starting point in that pursuit, although I had not an opportunity to attend lectures there."

Many years later Dr. Silliman revisited Princeton, and he said to President Maclean upon visiting the chemical laboratory: "It was in this room that I witnessed the first experiments in chemistry."

The younger Professor Silliman, of Yale, in a paper entitled "American Contributions to Chemistry," read July 31, 1874, on the occasion of the Priestley Centennial, said: "Of the public seminaries of learning other than medical institutions where chemistry was taught from a separate chair, and as a distinct branch of the college curriculum of instruction prior to 1800, we find but one, and that distinction belongs to Nassau Hall, Princeton, New Jersey."

It should be stated in this connection, however, that James Hutchinson and Dr. James Woodhouse of the University of Pennsylvania, Aaron Dexter of Harvard, and Dr. Samuel Mitchill of Columbia were contemporaries of Maclean, and taught more or less chemistry at a very early date in those institutions.

From the notebook of Howard we learn that there were thirty-seven "simple substances" at that time. Those substances were regarded as "simple" the composition of which was unknown, while compound substances were those which had been analyzed. The following were classified as simple substances:

caloric	silex	fluoric acid	antimony
light	alumine	boracic acid	mercury
electricity	magnesia	arsenic	zinc
oxygene	lime	tungstein	tin
azote	barytes	cobalt	lead
hydrogene	strontites	molybdena	copper
sulphur	pot-ash	bismuth	silver
phosphorus	soda	nickel	gold
carbone	muriatic acid	manganese	platina

These thirty-seven "simple substances" constitute the titles of so many chapters in the notebook. Seventeen of these were regarded as metals. which were divided into semi-metals (brittle) and metals.

From the notebook we also learn that Dr. Maclean gave a second course in chemistry, which had to do with living or animated bodies. This was a much shorter course, dealing with the structure and organization of vegetables, vegetable productions, fixed gross or fat oils, volatile oils, the composition of vegetables, and tanning and currying. It thus appears that Dr. Maclean gave attention to the relation of chemistry to agriculture and industry, as well as to medicine.

It might be of interest to quote two or three passages found in this re-

markable notebook. The first has to do with the importance of chemistry, and runs as follows: "Chemistry enables us to explain many of the changes which this globe undergoes; to comprehend many important phenomena which strike us with wonder and admiration; to invent, improve and bring to perfection many arts and manufactures conducive to our own comfort and happiness; to draw entertainment from the contemplation of appearances which habit has rendered familiar and indifferent to us, and finally by making us more intimately acquainted with the works of the Creator, to enlarge our ideas of his Wisdom, Power and Glory."

In the chapter on gold we find the following: "Gold melted with an alkaline sulphur forms a compound soluble in water. It has been supposed that Moses dissolved the golden calf of the Israelites by means of the sulphur of soda."

The following statement concerning oxygen was written years before its liquefaction: "The term 'gas' expresses a state or form to which bodies are reduced by the operation of caloric. Hence oxygene gas means oxygene in the state of gas. If the gaseous state of a body be owing to its combination with caloric, oxygene has never been found free and uncombined. For oxygene gas retains its form at the lowest temperature with which we are acquainted. It is hence called a permanent gas."

Wonderful strides have been made in the field of chemistry since Dr. Maclean came to Princeton to teach, which was just 21 years after Priestley discovered oxygen. At that time there were about twenty-five known chemical elements; now there are eighty-three well-defined elements in the Table of Atomic Weights. In Howard's notebook there is neither symbol nor formula; for Berzelius, the great Swedish chemist, did not introduce chemical symbols until 1811. "Lime" was called a "simple substance," for Davy did not isolate the alkali and alkaline earth metals until 1807–1808. There are, of course, no known "permanent gases;" for even helium, the most refractory of all, has been liquefied, giving us a temperature near the absolute zero. Other discoveries have been equally significant and remarkable.

ABSTRACT FOR BALTIMORE MEETING. (Too late to classify.)

Teaching Principles of Electrodeposition 15 min. (Illustrated)—W. Blum

The importance of potential relations, and especially of single potentials during deposition, is emphasized. Potential changes involved in polarization can be most simply explained in terms of the changes in "effective metal ion concentration." From polarization curves it is often possible to predict the direction of the effect of different variables upon the distribution and crystalline structure of the deposited metals.

TYPES OF THOUGHT QUESTIONS IN CHEMISTRY LABORATORY MANUALS

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Some four years ago, when I was principal of a high school in central Illinois, I received from the Bureau of Education Research of the University of Illinois, a bulletin giving twenty different types of thought questions. The purpose of the bulletin was to find out the extent of the use of the different types of thought questions in actual school practice and to get the teachers' judgment of the relative difficulty of the different types. Many of us, who received that questionnaire, had never before been conscious of the fact that there were so many definite and distinct types of thought questions. In practice we had been using a very few types, such as "pure memory," "discuss," and "selective recall." During the past summer, I assigned my class in "The Teaching of High School Chemistry" the task of finding out what types of questions are most often used in high school chemistry laboratory manuals. The types of questions given them to use as a basis for their classification were as follows: All of these except the first two are taken from the Illinois bulletin.

1. Pure memory questions
2. Questions involving observation only
3. Selective recall—basis given
4. Compare two things—on a single designated basis
5. Compare two things in general
6. Decision—for or against—choice or preference
7. Give causes or effects
8. Explain the use or meaning of some phrase or statement in a passage
9. Summarize—some unit in the text, article read, or experiment performed
10. Analyze (The word itself is seldom involved in the question)
11. State relationships
12. Classify (usually the converse of 13)
13. Give illustrations or examples (your own) of principles
14. Evaluating recall—basis given
15. Suggest or make applications of rules or principles in new situations
16. Discuss
17. Questions of aim—author's purpose in his selection or organization of material
18. Criticize some statement—as to adequacy, correctness, or relevancy of a printed statement
19. Give a brief outline
20. Reorganize facts learned in one organization on a new basis
(A good type of review question to give training in organization)
21. Questions on new methods of procedure
22. Questions on problems and questions raised. What question came to your mind? What else would have to be known in order to understand the matter under consideration? etc.

In the following table we have represented the number of questions of each type occurring in seven different laboratory manuals.

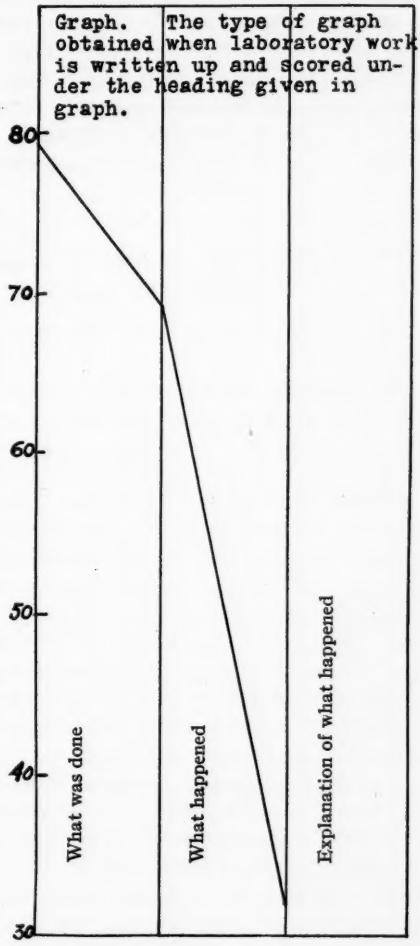
LABORATORY MANUALS

Types of questions	A	B	C	D	E	F	G	Total for each type
1	15	23	40	15	6	138	32	269
2	93	66	144	300	145	165	130	1043
3	18	11	5	38	49	91	285	497
4	0	10	13	38	16	15	29.5	121.5
5	4	6	0	23	6	25	34	98
6	0	0	15	12	6	16	15	64
7	14	3	29	12	150	29	64	301
8	0	1	0	35	3	7	6	52
9	0	5	30	37	27	11	5	115
10	0	2	121	61	32	11	14	241
11	14	0	6	5	3	4	8	40
12	0	1	1	24	16	10	2	54
13	0	0	0	0	1	10	0	11
14	4	0	7	7	0	15	15	48
15	0	2	65	9	2	2	14	94
16	0	1	1	17	4	12	4	39
17	0	0	0	0	2	1	0	8
18	0	0	0	0	0	2	0	2
19	0	0	0	10	1	6	0	17
20	0	1	0	1	2	2	0	6
21	3	0	0	0	2	4	0	9
22	0	0	0	0	3	0	0	3
Totals for each manual	165	132	477	644	476	576	657.5	3127.5

From the table we can see that more than one third of all the questions involved in this study are either pure memory questions or observational questions. Observation is an important step in scientific thinking and the step which natural science is best able to give, but it should be looked upon as only one step in a process and not as an end in itself. If our training goes no farther than the development of memory and observational powers, we cannot expect to give efficient training in scientific thinking. Are we really training students to think scientifically?

For two years I gathered data from four classes in natural science bearing upon this point. Practically all laboratory experiments were written up under three headings: (1) what was done; (2) what happened; and (3) an explanation of what happened. For each experiment, the number of points that should be included in a complete "write up," under each heading was listed. The number of points made under each heading was then counted and the score under each heading was calculated by dividing the number of points made by the number that should have been made. The accompanying graph shows the total scores made by two classes under such a procedure, during one year of work. This graph is typical of all the graphs that I have seen bearing upon this point.

Under "what was done," we are dealing mostly with memory. Under "what happened," observation is the important thing. Under "explanation," scientific thinking is the factor most important; and scientific thinking is evidently the thing that is lacking. We, as science teachers, are evidently making an absolute failure in our efforts to attain one of the aims of natural science teaching. Why are we failing?



From a study of the accompanying table, it is clear that writers of textbooks and laboratory manuals are absolutely unconscious of the fact that there are many definite and distinct types of problems. Teachers as a group are, of course, much less aware of types of problems, if such a thing can be possible.

In chemistry, we often have a student jot down a point or two in answer to a question and then settle back in his seat thinking his task is done. When his attention is called to the fact that his answer is very incomplete and when the points that should have been included are mentioned, he very often says, "why I knew that." What, then, was the trouble? In many such cases, the trouble is not a lack of knowledge of the subject but the lack is in not knowing what is involved in a complete answer to a problem of the particular type under consideration. Such a student needs training in restating his problems and in breaking them up into questions. He needs training in best methods of solving his problems.

We, as teachers, need not only to be conscious that there are a very great

number of types of problems but we need to be conscious that there is a best method to follow in solving each type. We need, furthermore, to know definitely just what that best method is. When this consciousness has once dawned upon us, as teachers, we need to pass it on to our students in natural science. Before they leave us they should have stored away in their minds samples of the various types of problems and samples of the best method to follow in solving each type; so that, when they get out into the world, they will be more able to classify the problems of life as they arise and use the best method in their solution. By some such procedure, we shall go far in advancing the pedagogy of natural science teaching, and in discovering the mental processes involved in scientific thinking.

THE PLACE OF TECHNICAL WORK IN AN ELEMENTARY CHEMISTRY LABORATORY MANUAL

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An important question to be considered in the selection of a manual for laboratory work in elementary chemistry is the place of practical qualitative and quantitative analysis. Most authorities in chemistry consider all experiments as belonging either to the qualitative or quantitative class. According to them no matter how theoretical an experiment may be, no matter how it pertains to general properties, if it does not involve definite weights or volumes, it is a qualitative experiment. For this reason it is hard to obtain exact data from the schools of the country as to the situation regarding the relative number of general experiments, qualitative experiments, and quantitative experiments conducted in these courses. In this connection we are regarding all experiments involving methods of preparation, properties, validity of laws, etc., tests which are not made according to any set scheme, and products of reactions, not weighed or measured; as general experiments.

In our investigation concerning the conditions of laboratory work in the accredited schools of the North Central Association, we found that the amount of qualitative work varied from ten per cent to eighty per cent. We have no way of telling how much of this is done according to a systematic scheme, but are compelled to judge that in the cases in which it runs as high as eighty per cent that it is not carried on according to any systematic scheme. We know of no manual which provides for more than $33^1/_3$ per cent of qualitative analysis according to a system. A few manuals provide this much. Some teachers lay aside the manual and give one third of the time to qualitative analysis according to a scheme of their own.

In surveying the literature from the time chemistry laboratories were installed in the high schools for the use of students to the present time, we do not find many advocates of a set scheme in qualitative analysis. There are some authorities who argue in favor of it for freshmen in college.

John E. Lansing[1] says there is time for a satisfactory course in qualitative analysis in first year college chemistry, providing five credit hours are available during the entire year. Now, according to standard methods of estimating high school credits this would be the equivalent of a year and one-half or two years of high school chemistry. Then Lansing says that he would not under the circumstances, sacrifice the theoretical side of the subject in order to get through the greatest possible number of "unknowns," but he would give the time to preliminary reactions.

The most approved manuals at the present allow no time for a system of qualitative analysis, although some of them give a few experiments on the separation of members of some of the groups. It would seem as though a few such separations might be all that is justified in the elementary course. The argument is that only practical work of this sort will keep the student interested. It is claimed that the student takes a delight in finding out what a certain unknown substance is and because of this his chemistry is attractive. While we do not dispute this claim, we will claim that at no time during the first year should this practical work be started. It spoils the student for laying any more foundations.

Whatever the proportion of systematic analysis, that part should come last in the course, regardless of the place of the element involved in the periodic table. The type of thinking involved in analytical work is easier, perhaps, than that involved in most of the general work. If this is true, the truth does not depend entirely on the difference in interest in the two classes of work, but it depends a great deal on the matter of how well the worker has laid his foundations. It may depend largely on the fact that in general work the student has the will to think and in analytical work he does not have the will to think, but thoughts force themselves upon him.

We feel sure, too, that if the student undertook to do the analytical work, even some unsystematized qualitative tests, the thoughts which forced themselves upon him would be questions and problems that would be impossible of solution without a knowledge of some fundamental principles.

In deciding upon this arrangement, we have to overcome all of the claims concerning native interest. There is no doubt that in the mind of the beginner in chemistry, the curiosity concerning the methods of finding out what is in certain things, what elements make up certain unknown compounds, is uppermost. But to begin to teach the student these methods in order to satisfy that curiosity would be to destroy him.

[1] *J. Chem. Ed.*, **1**, 72 (1924).

Lyman C. Newell[2] says, "Some students have their native interest so pampered that they become unfitted for much mental work beyond passive or desultory observation."

"We must will to think if we are to live." He then repeats a saying of Professor Ladd: "What I will to think becomes interesting and attracts further attention to itself."

So we must conclude that even if it were possible to train a student in a system of qualitative analysis before he had had any work with the fundamental principles, or to give him such qualitative work as might be interspersed with fundamentals, we would soon be making an apprentice of the student and a trade of a highly specialized profession.

Regarding the place of quantitative work in the beginners manual we would probably be expected to recommend that if there is any quantitative work to be done, it be left to the very last, after the qualitative which follows the general work. This certainly would be the case if we thought of any systematic quantitative analysis. It would of necessity follow the qualitative work. But if we are going to intersperse a little bit of quantitative work in order to satisfy the students native curiosity and hold his native interest we would say this can be done with less damage to the development of the student that would be the case with qualitative work. It is possible to find a few exercises involving weights and volumes which are not inclined to make the student think he is a chemist, and which at the same time are not too technical. As to the place of technical work in laboratory manuals, L. C. Newell, when they were first getting laboratory work started in the high schools, recommended some experiments requiring accurate weighing, saying it would make the high school course more profitable. He says in the first part of the work, "Let the students weigh a liter of oxygen and after that sort of experiment students will more cheerfully perform mathematical calculations, because they will want to see how their results come out."

It is in this sort of exercise in which we agree that the results must be obvious and not hard to get, for students will not cheerfully repeat tedious quantitative experiments which do not figure out according to standards, the first few times. Neither will they cheerfully attack new quantitative problems. This is the sort of experiment which we do not want to overdo. Quantitative exercises should be few and simple or else the student tires and loses interest. The few that are used should involve fundamental laws and calculations according to fundamental rules. If we were to state definitely how many quantitative experiments should be required in a high school course we should say not more than six and they should be the simplest to be found which would involve work with the simple more familiar substances and which would involve familiar properties and fundamental

[2] *Sch. Rev.*, 9, 286 (1901).

principles. McPherson and Henderson in their "Laboratory Exercises," for the first course in chemistry in which they give one hundred and one experiments in all, give only eight quantitative exercises and four of them are optional. This means that those popular authors would give not more than six quantitative experiments in the average high school course.

Peters, in recommending practical work for high school students, says that they should have at least fifteen quantitative experiments in the year's work, and that with these experiments they should prove equations representing chemical reactions. It is hard to see how high school students could ever accomplish this much without using from one-half to three-fourths of the entire laboratory time, unless those quantitative experiments involve such simple determinations as finding the weight of common salt that could be dissolved in one hundred cubic centimeters of water. Even such determinations would have to be determined roughly. The simplest equation to be proven would require twice as much work as would this one, and would require more time than two double periods of fifty minutes each.

H. N. Goddard,[3] in his observations in the high schools, says there is a great tendency among high school students to avoid laboratory courses because they take too much time or because of tedious notebook work, or the laboratory work is lacking in interest.

This would certainly serve as an argument against having so much quantitative work in the high school laboratory course. We might think we were successfully refuting this argument by claiming that the student is held for a limited time regardless of the character of the work. If even this is true, faithful students are going to put in extra time in order to finish tedious processes already begun and still maintain that the technical experiment takes too much time.

If proper adjustments are made regarding preparation of textbook or library assignments it will not be difficult to convince students that they lose no more time from the laboratory credits than they receive for the others if we keep them off those tedious quantitative experiments. Neither will the student conclude that he is spending too much unprofitable time in tedious notebook work if the notebook is kept in a scientific manner and notes are made as the work proceeds, and nothing unreasonable is required in the notebook.

Since the subject of this discussion is "The Place of Technical Work in the Elementary Chemistry Laboratory Manual" we feel justified in saying something about the size of that place, not that we want to add to what has been said about the number of qualitative or quantitative experiments, but that we offer some suggestions as to the character of the directions for such work.

[3] *School Science and Math.*, **16**, 710 (1916).

Judging from what has been done by authorities in the past, we would conclude that the extent of the work would determine the amount of directions given. We have noted in the most popular manuals that quantitative work is not assigned to any definite order. This seems perfectly proper. So in this connection we will confine our consideration to the qualitative work.

We note that the most popular manuals leave what they do give on a qualitative scheme to a small place in the latter part of the manual. We are agreed as far as the latter part of the manual is concerned. We are also agreed as far as the smallness of the place is concerned providing the number of experiments is correspondingly small. In a few of the popular manuals, effort is made to cover a complete scheme for separating the metals and nonmetals. All of this is undertaken with directions covering not more than ten or fifteen pages. The ten or fifteen pages are given to group tables with very meager notes. It is supposedly done in this fashion for the sake of simplicity.

We would be inclined to suggest if qualitative chemistry is given a place in high school chemistry, that of all the directions given the student, the directions in this work should be the most elaborate. We would say instead of taking the high school student over a complete qualitative scheme with ten pages of directions, and leaving Prescott and Johnson's or Wilfred Wielday Scott's comprehensive notes for the college student, that the order might better be reversed. But since we do not have time in a high school course to get a decent start in one of these elaborate manuals, the better thing to do is to let the scheme alone, and do a small amount of attractive identification and separation work such as is directed in McPherson & Henderson or Newell's Manuals.

HOW LONG DO STUDENTS RETAIN WHAT THEY HAVE LEARNED FROM HIGH SCHOOL CHEMISTRY?*

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A frequent criticism of high school chemistry is that such information and such skill and ability as are acquired by those who study it, is rapidly lost by forgetting. Tests of the truth of this criticism contribute an important criterion for evaluating this subject of study. Opportunity to test the amount of retention (or amount of forgetting) of certain facts and abilities was provided when permission was granted to test the Freshmen entering at the University of Minnesota who had studied chemistry in high school.

* Printed also in Yearbook of the New York Society for the Experimental Study of Education. Copyrighted 1924. Reprinted by permission.

Students taking chemistry are differentiated on the basis of previous training in this subject. Those who had studied chemistry in high school are grouped together during the first year for purposes of instruction. The tests were given at the first meeting of the class which entered in the fall of 1921. All those taking the tests had studied chemistry in high school and had elected chemistry in the University. In all, 349 beginning students were tested. The largest proportion of these had completed high school chemistry in June of the same year and had entered the University in September. For these the time interval between completion of the high school course and the taking of the test was three months. There were others who had completed high school chemistry in June, 1920. For this group the time interval between last instruction in chemistry and taking the tests was one year and three months. There were others for which this time interval was two, three and up to as long as 17 years. The students are grouped according to the years during which they studied high school chemistry. No effort was made to determine how these students had been occupied during the interval which elapsed between the period of their instruction and their entrance to the university. It is likely that many of those from the group which had completed the high school course as early as 1918 were deferred from entering the University on account of entrance into military service. There are many circumstances which may have operated to keep students from entering the university for one or two years after graduation from high school. If the cause of determent were known it would probably contribute little or nothing to the interpretation of the facts reported in this paper.

Two tests were used. One was a test of what may be called more or less mechanical abilities. It was a test of ability to write formulas and equations; to classify elements, mixtures and compounds; and to classify elements according to their activity. This test consisted of 77 items. Previous to its use with these freshmen the test had been used in 20 high schools. The high school students were tested near the close of the school year. The scores of these students are an index of ability to do these tasks immediately following a period of one year's instruction.

This first test of 77 items was made up of seven parts. A definite notion of the nature of each division may be given by quoting the directions and one test item from each division. Table I is presented to illustrate the nature of the test. It also gives the numbers of items included in each division of the test.

TABLE I

One test item from each division of the test.

I. Write the names of the following compounds. NaOH.

There were 12 formulas in this division.

II. Write the molecular formula for the following: Hydrogen peroxide.

TABLE I (*Concluded*)

There were 12 names in this division.

III. The valence of the following elements and radicals is as indicated: Mg^{++}, Al^{+++}, Li^{+}, Br^{-}, SO_4^{--}, PO_4^{---}, Cl^{-}. Insert subscripts where they are needed to make the following formulas correct: Al Cl. There were 9 incomplete formulas in this division.

IV. Place a letter A before each element that is above zinc and a letter B before each element that is below mercury in the activity series: Magnesium.

There were 12 elements named in this division.

V. Place a letter C before each substance listed here if it is a compound and letter E if it is an element and a letter M if it is a mixture: Iron.

There were 12 substances named in this division.

VI. Fill in the righthand side and balance the following equations:

NaOH + HCl.

There were 10 incompleted equations in this division.

VII. Write the equation, using correct molecular formulas, for each of the following chemical changes. The preparation of hydrogen chloride from sulfuric acid and salt.

There were 10 chemical changes named in this division.

Attention is directed to the scores made on each division of the test by the students still in high school who were just completing a year's work in chemistry and to the scores of the university students in each of the groupings made according to the year during which they had studied high school chemistry. The scores, given in Table II, are in terms of the percentage of possible responses to the items of a given group which were correct. There were for example, 12 items in the first division of the test. If 1200 students took the test the possible correct responses to the items of this division is 14,400. A score of 72 indicates that 72 per cent of the 14,400 possible responses were made correctly. The table gives the percentage of the possible responses for the entire test and for each division which was correct.

An analysis of the percentages in Table II shows that some divisions of the test caused more difficulty than others and that the ability to do some divisions was lost much more rapidly than ability to do other divisions. In general those divisions which were most difficult were the same as those in which ability was lost most rapidly. The first division is a test of ability to write the names for given formulas. Seventy-two per cent of the possible responses to these items were made correctly, by individuals still in high school. Slightly more than one-third of the possible responses were made correctly by the students for whom the time interval between instruction and taking the test was four years or more. The second division tests ability to write the formulas for given substances. These items cause somewhat more difficulty than those of the first division and only one-tenth of the possible responses were made correctly by students for whom the time interval between instruction and the test was more

than four years. The third division is a test of ability to construct formulas from given radicals and their valences. These items cause least difficulty for the high school students and those for whom the time interval between instruction and the test is but three months. After the time interval has become as much as a year it appears that this ability is rapidly lost. Ability to do the items of the fifth division appears to be lost least rapidly. This is a test of ability to classify substances as elements, mixtures and compounds. Divisions 6 and 7 are the most difficult and it is clear that such ability as students acquire to do these items is rapidly lost. It must follow from the facts given that a large proportion of the students taking the test are unable to do any of the items correctly when the percentage of correct responses is as low as six. The items of the seventh division are particularly difficult for students who have been separated from instruction by only a short time interval. Hardly any of the responses were made correctly by students for whom this time interval was four years or more, yet nearly one-half of the responses to this group of items were made correctly by those who took the tests while still in high school. For each division of items the percentage of possible responses which were correct decreases rapidly from year to year.

TABLE II

PER CENT CORRECT RESPONSES FOR THE ENTIRE TEST AND FOR EACH DIVISION

	1	2	3	4	5	6	7	Entire test	Cases
High School Students	72	63	82	64	68	51	49	63	1200
Entering Freshmen:									
1921	71	43	88	52	72	48	36	58	25
1920	63	29	66	34	60	25	9	40	25
1919	50	20	40	31	52	18	4	31	25
1918	46	18	38	26	56	14	3	27	21
Previous to 1918	34	10	24	14	43	6	0.6	19	17

Table II gives the percentage of correct responses to the items of the entire test. This is a rough measure of the difference in ability of the different groups. A more satisfactory measure of this difference is one which is stated in terms of scale units.

A scale was developed from the results obtained by giving the test to the students in high school. The test was scaled by selecting from it 30 items of such difficulty that each succeeding item differed in difficulty from the one immediately preceding it by approximately 0.1 P. E. The correct responses made by each high school student to each item of the scale were counted and from this a scale score was computed for each of the high school students that took the test. The method used for computing the scores is the one perfected by Van Wagenen and described by Monroe[1] as the Level of Difficulty Method. The zero point of the scale was set at 8.8 P. E. or 88 deciquartiles below the median. The scale scores are in

[1] Monroe, "Theory of Education Measurement," pp. 118–131.

terms of deciquartiles above the zero point. It follows therefore that the standard median for the 1200 students who were tested while still in high school is 88. The first and third quartiles are respectively 80 and 96. After the scale had been developed scores were computed for each of the individuals in each of the year groups. Median scores together with the number of cases in each group are given in Table III. The curve corresponding to these data is not unlike that of the curve which represents the rate of forgetting of nonsense syllables. The loss by forgetting is at first quite rapid. The rate of loss from students who have been away from their work for as much as a year appears to be slower. This may, however, be only apparent and an indication of the inadequacy of the scale as a measuring instrument for students who possess very little information. A scale score of 75 corresponds to 8 correct answers out of 30; the score of 69 corresponds to 4 correct answers. It is likely that if the range of the scale had extended as far as ten or fifteen deciquartiles farther in the direction of easier items that the actual amount of retention would have been shown to be even smaller.

TABLE III

MEDIAN SCORES FOR HIGH SCHOOL STUDENTS AND FOR YEAR GROUPS

Year groups	Median	Cases
High School Students	88	1200
1921	81	142
1920	76	98
1919	75	40
1918	73	27
1917	71	22
1916 and earlier	69	30

Interpretation of the data in Table III shows that 75 per cent of the students who took the test while still in high school are above the median for those who took the test three or four months after leaving high school. The difference in the ability of these two groups would certainly appear larger if correction were made for the effect of the selective factor. Entrance to the university is in itself a selective factor and furthermore chemistry appears to be selective of the students of the best ability within the university. The median score of individuals who had been out of school for as much as three years is approximately 2 P. E. lower on the scale than that of those who took the test while still in school. This indicates that more than 90 per cent of the high school students scored above the median of those who completed their high school course in chemistry in 1918. The differences are larger as the period of time between instruction and the test becomes longer until it appears that only the most elementary notions are retained by those who are away from instruction for any considerable period of time.

The position of each group on the normal surface of frequency which represents the distribution of the scores of 1200 high school students is shown in Figure 4.

It would be pertinent to inquire concerning the amount of information retained by the still larger proportion of students who took chemistry in high school and who did not enter the university. What functional value does the traditional course in high school chemistry have for the student who leaves school at the end of the high school course? It is pretty well established that this group is of lower mental ability. It would seem in vain therefore to expect for this group a larger functional value for the subject matter.

Limited data from the use of the multiple-choice-completion test of range of information given to the same students indicates similar results. The exception should be noted that the rate of forgetting of the abilities tested by this test is somewhat slower. This test appears to demonstrate the selective tendency of entrance to the university, for the scores of those who entered the university just three months after completing high school chemistry were somewhat higher than the scores of those who took the test while still in school. The group who had been away from instruction for a year did not do so well. The scores of those two years or more away from instruction were much lower. In this test, as in the first, the results indicate that only the very elementary notions are retained for any considerable period of time. The scores for the different groups are given in Table IV. The scale units in this table are derived in the same way as those in the table immediately preceding.

TABLE IV

MEDIAN FOR TEST 2

	Median	Cases
High School Students	88	794
1920–21 group	90	49
1919–20 group	87	21
1918–19 or earlier	74	24

In the light of these facts there is no escape from the conclusion that specific information about the subject matter of high school chemistry is rapidly forgotten. The interpretation of the results and the influence which they should exert in effecting practices may be controverted. The absence of functional value of the subject matter which is forgotten is established by the fact that it is forgotten. We do not forget how to do the things we are doing nor do we forget the facts we are using. In the absence of functional value there remains the possibility of a training value. "Training in methods of memorizing, acquiring skill, solving problems, and in maintaining proper attitudes is an important task in education, as well as the mere accumulation of information and skill." A paramount

problem in education is that of selecting the proper methods and the most appropriate subject matter for accomplishing this training. The teachings of psychology put into question at once, the effectiveness of a non-functional subject matter for purposes of training. Quotation from authority will be substituted for discussion of this point. Gates says: "For two reasons we may expect a greater transfer to the activities of daily life from subject matter which is itself directly useful in situations commonly encountered outside of school. First in order to deal with the situations in life we need to know the facts involved. Second the transfer of methods of attack, interest, poise, devices of learning, habits or ideals of caution, accuracy, thoroughness, or initiative to the situations in life will be great to the degree that the subject matter of the classroom is identical with that used in situations which life itself offers. We should, then, other things being equal, prefer genuine life issues and widely usable facts rather than unreal and fantastic problems or trivial, unusual or academic facts." [2] This is no doubt a fair statement of the point of view of present day psychologists and in accord with facts available. In another paragraph Gates considers the possibility "that certain subjects whose contents as such are not widely used in life nevertheless deserve consideration because the kind of activities demanded offer exceptionally effective opportunities for training and disciplining mind and character." But he says, "Finally, we must consider in just what degree habits developed in the subject do actually transfer to others, and recall that in so far as the content is unrelated to life, transfer will be relatively small." [3]

There is no escape from the conclusion that a non-functional subject matter is ill-adapted for training. Certainly more appropriate subject matter for instruction in chemistry should be selected and there is at hand a wealth of material from which to select. Faulty methods are no doubt another contributing cause of lack of effectiveness of instruction in chemistry. Another important task is therefore that of defining proper methods of presentation. Certainly there is urgent need for a critical examination of both the traditional materials and the traditional methods which are now used in the high school course.

Dr. Henry C. Sherman, Mitchill Professor of Chemistry in Columbia University, lectured on enzymes and vitamins at the Iowa State College (Ames) February 16 and 17; Iowa State University (Iowa City) February 18; University of Minnesota, February 19 and 20; University of Illinois, February 23; University of Michigan, February 25; and on vitamins at the Ohio State University, February 26. The lectures were given under the joint auspices of the graduate schools or scientific societies of the college or university and the local sections of the American Chemical Society.

[2] Arthur I. Gates, "Psychology for Students of Education," pp. 37–72.

[3] *Ibid.*, p. 373.

SUGGESTIONS TO TEACHERS OF BIOLOGICAL CHEMISTRY.

I. THE CLASSIFICATION OF LIPINS

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The classifications of carbohydrates and proteins have been well worked out and have proven quite satisfactory. Not so with the classification of lipins, for in this field much confusion of terms yet occurs. Thus the term lipin and lipoid are used interchangeably by many authors. Since the tentative classification of Rosenbloom and Gies[1] no further attempt has been made in the classification of the lipins.

The classification now proposed divides the lipins into two main divisions: the *true lipins* and the *lipoids*. In the true lipins are included all ether soluble or alcohol-ether soluble compounds, which yield on hydrolysis fatty acid and alcohol. In the lipoids are to be found all ether soluble or alcohol-ether soluble compounds of biologic occurrence, which are not esters holding in combination fatty acid and alcohol, such as the sterols and the essential oils.

The true lipins, following closely the nomenclature for proteins, are subdivided into *simple lipins*, *conjugated lipins* and *derived lipins*. The conjugated lipins are further grouped into classes which bear close analogy to those in the conjugated proteins. The chromolipins, phospholipins, and glycolipins find similar prototypes in the chromoproteins, phosphoproteins, and glycoproteins. The derived lipins, like the derived proteins, represent hydrolytic decomposition products. The close resemblance in the nomenclature followed for protein and for lipin is of obvious advantage to the student.

The Classification of Lipins

The term "lipin" is applied to a class of biologic substances soluble in ether or in an alcohol-ether mixture.

The lipins may be divided into two main groups: true lipins and lipoids.

True Lipins

The true lipins may be classified into three groups: simple lipins, conjugated lipins and derived lipins.

I. SIMPLE LIPINS

(Compounds which yield on hydrolysis, fatty acid and glycerol or fatty acid and a monohydric alcohol of high molecular weight.)

a Fats—Neutral esters of glycerol and fatty acid which are solid at 20° C.

b Fatty oils—Neutral esters of glycerol and fatty acid which are liquid at 20° C.

1 Drying oils—These harden on exposure to light and air. Example: linseed oil.

[1] J. Rosenbloom and W. J. Gies, *Biochemical Bulletin*, **1**, 51 (1911–12).

2 Semi-drying oils—These thicken slowly on exposure to light and air. Example: cottonseed oil.

3 Non-drying oils—These remain liquid on exposure to light and air. Example: olive oil.

c Waxes—Esters of the higher alcohols such as cetyl alcohol, myricyl alcohol, etc., with fatty acids. Example: beeswax, carnauba wax.

II. CONJUGATED LIPINS

(Compounds which yield on hydrolysis, not only fatty acid and alcohol but some other complex such as sulphuric acid, phosphoric acid, monosaccharide, amino acid or some organic base like choline or neurine.)

a Phospholipins (Phosphatides)—These yield on hydrolysis, fatty acid, glycerol, phosphoric acid and some organic base like choline, neurine, etc. Example: lecithin; cephalin; sphingomyelin. [2]

b Glycolipins—These yield on hydrolysis, fatty acid, glycerol and a monosaccharide such as glucose or galactose. Example: cerebrin, phrenosin, kerasin.

c Glycophospholipins—These yield on hydrolysis besides fatty acid and glycerol, phosphoric acid and also a monosaccharide. Example: jecorin.

d Sulpholipins (Sulphatides)—These yield on hydrolysis, fatty acid, glycerol and sulphuric acid. Example: protagon.

e Sulpho-phospholipins—These yield on hydrolysis, fatty acid, glycerol, sulphuric acid and phosphoric acid. Example: sulpho-phospholipin of lung.

f Aminolipins—These yield on hydrolysis amino acid, fatty acid and glycerol. Example: bregenin.

g Proteolipins—These are lipins in conjugation with protein. Proteolipins, in which the prosthetic group is a higher fatty acid, are easily made artificially although their existence in biologic tissue is still doubtful.

Proteolecithin is a type of proteolipin found in cytoplasm and in limiting membrane. The prosthetic group is lecithin or some other phospholipin. None of this type has thus far been isolated.

h Chromolipins—These are colored organic compounds soluble in the usual lipin solvents. Example: yellow pigment of egg yolk, of butter fat and of xanthomas, of staphylococcus pyogenes aureus and of staphylococcus pyogenes citreus.

III. DERIVED LIPINS

(Compounds other than phosphoric acid, sulphuric acid, amino acid or monosaccharide, obtained as a result of the decomposition of lipins.)

a Fatty Acids—Example: oleic acid, linoleic acid, palmitic acid, stearic acid.

b Alcohols—Example: glycerol, myricyl alcohol.

c Organic Bases—Examples: choline, neurine, oxyethylamine, oxyamino-butyric acid.

Lipoids

(Compounds not esters of fatty acid and alcohol, but which are closely

[2] The phospholipins have been customarily subdivided into groups varying in the number of atoms of nitrogen and phosphorus contained. The recent work of Levene and also of MacLean[3] point to the fact that only three lipins—lecithin, cephalin and sphingomyelin—have a definite composition and that the others are mixtures. In view of this finding, an elaborate sub-grouping of phospholipins seems unwarranted.

[3] P. A. Levene, *Physiological Reviews*, **1**, 327 (1921).

associated with lipins and resemble them in their solubility in ether or alcohol-ether.)

The lipoids may be subdivided into two groups:

I. Sterols—These are alcohols, solid at the ordinary temperature, readily soluble in ether and in chloroform, and easily crystallized. Example: cholesterol, phytosterol, stercorin, coprosterin.

II. Essential Oils—These are volatile, oily and generally odoriferous substances of varied chemical nature, being aldehydes, acids, terpenes, alcohols, etc. Example: oil of cloves, turpentine, oil of wintergreen.

The acids entering into the composition of lipins may be conveniently divided into groups which follow:

A. Straight-Chained or Aliphatic Acids.

I. Saturated Acids.

a Monocarboxylic Acids.

1 Saturated fatty acids of the general formula $C_nH_{2n-1}COOH$. Example: palmitic acid ($n = 15$), stearic acid ($n = 17$).

2 Hydroxy acids of the general formula $C_nH_{2n}(OH)COOH$. Example: lanopalmic acid ($n = 15$) in wool fat; cocceric acid ($n = 30$) in cochineal wax.

3 Dihydroxy acids of the general formula $C_2H_{2n-1}(OH)_2COOH$. Example: dihydroxy stearic acid ($n = 17$) in castor oil, lanoceric acid ($n = 29$) in wool fat.

b Dicarboxylic acids of the general formula $C_nH_{2n}(COOH)_2$. Example: japanic acid ($n = 20$) in Japan wax.

II. Unsaturated Acids.

a Unsaturated acids with one double bond of the general formula $C_nH_{2n-1}COOH$. Example: oleic acid ($n = 17$).

b Unsaturated acids with one double bond and hydroxy group of the general formula $C_nH_{2n-2}(OH)COOH$. Example: ricinoleic acid ($n = 17$).

c Unsaturated acids with two double bonds of the general formula $C_nH_{2n-3}COOH$. Example: linoleic acid ($n = 17$).

d Unsaturated acids with three double bonds of the general formula $C_nH_{2n-5}COOH$. Example: linolenic acid ($n = 17$).

e Unsaturated acids with four double bonds of the general formula $C_nH_{2n-7}COOH$. Example: clupadonic acid ($n = 17$) in Japanese sardine oil, isamic acid ($n = 13$) in a vegetable from the French Congo, therapic acid ($n = 17$) in cod-liver oil.

B. Cyclic Acids.

Example: hydnocarpic acid and chaulmoogric acid found in chaulmoogra oil.

Both acids have the same molecular formula as linoleic acid. Instead of absorbing four atoms of bromine, chaulmoogric acid absorbs only two. The second unsaturated linkage occurs in cyclic formation.

NEW APPLICATIONS OF BIOLOGICAL STAINS

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Dyes have certain applications which are very seldom taken into account by chemists. The textile industry uses dyes in such large quantities that their use of these products completely overshadows another very important application, namely, various laboratory applications by biologists. The amount of actual dye-stuffs used for this purpose is very small, but the use is an invaluable one, partly because of the dependence of the biologist upon dyes in much of his laboratory work and partly because dyes are used in the laboratory in connection with disease diagnosis and other matters which have an important bearing on public health. It is hard for the ordinary student of dye chemistry to realize what highly complicated procedures of delicate dyeing have been developed in the biological laboratory.

This dyeing is not applied to materials in bulk but to microscopic preparations, and the colors produced are observed beneath the microscope. Objects of microscopic size and the microscopic details of tissues are all but invisible to the eye, even with the use of a high power microscope. This is because of their transparent nature and their lack of color. They can be made visible, however, by the use of the proper dyes, and in this way, biologists are able to study the minute details of nature.

It is well known that dyes differ not only in their color but in the readiness with which they dye different kinds of fiber or tissue. Some dyes can be used for cotton, others for silk, while many can be used for wool but not for either cotton or silk. In the same way different microscopic objects have affinities for different groups of dyes, but the case is even more complicated when tissues are viewed under the microscope than when they are examined in bulk. Certain minute bodies within the tissue take certain dyes, others different dyes, so that it is sometimes possible by staining with the right combination of dyes to bring out three or four distinct colors visible in a microscopic preparation. All this makes the problem of biological staining a very complicated one; but to the man who is skilled in the necessary technic, it makes it possible to distinguish much more in connection with microscopic structure than if all parts of the tissue took the same dyes.

The importance of this in biological research is easy to understand, but the part which biological stains play in public health is not so generally realized. A few illustrations given here will show somewhat the significance of dyes for this rather unexpected purpose.

Cultures are sent to the laboratory from suspected diphtheria patients. The bacteriologist, in order to learn whether or not the culture is one of the diphtheria organism, stains with some dye, which is usually either

methylene blue or toluidine blue. If a discharge is suspected of being gonorrhoea, it is examined under the microscope after staining with a dye of the methyl violet group, mordanting with iodine, decolorizing with alcohol and then restaining with some other dye of different color from methyl violet. Treated in this way the bacteria in question stain with the latter dye, while the others with which they are most likely to be confused retain the methyl violet. In cases of suspected tuberculosis, fuchsin is used in staining the sample of sputum submitted, subsequently decolorizing with a mixture of acid and alcohol and restaining with methylene blue. The tubercle organism retains the red of the fuchsin, other organisms lose it and become stained with methylene blue.

When it is desired to learn the number of bacteria in milk, it is possible for the bacteriologist to make a determination by a cultural technic long in use, if a day or two is given him to allow for incubation of the cultures, but by use of the microscope it is possible to get results in 10 or 15 minutes. In doing this the milk has to be stained with methylene blue which brings out the bacteria and leaves the background of milk almost uncolored. This determination is an important one and has many applications in connection with the sanitation of milk.

Such procedures as these show how dyes are constantly being used in the bacteriological laboratory in the interests of public health. At present it is hoped, moreover, that they may have great value in the future in the treatment of diseases as well. Medicine has long been hunting for drugs that can poison the disease germs without injuring the human body. Recent investigations seem to show that it may be possible to obtain them in numerous cases. Salvarsan (used in treating syphilis) is perhaps the best known specific drug obtained by modern research. Salvarsan happens to be a dye, and nearly all of the similar drugs recently produced are either dyes or very closely related to dyes. How this happens to be the case is not definitely explained, but it is one more instance of the value of dyes to public health.

The subject is a fascinating one and illustrations could be multiplied. This brief statement, however, is enough to show that the future will regard dyes not only as coloring matter for textiles and foods, but also as very important agents in the diagnosis and treatment of disease.

SHOULD TEACHERS DO RESEARCH WORK?

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The question as to whether or not a teacher should engage in research is being discussed at many of our educational institutions. The problem is an important one and exceptions are to be found to all arguments presented by both sides. The author is devoting part of his time to research and part to teaching, and so naturally was very much interested in the paper recently published by C. C. Hedges.[1]

One of the main objections offered against the pursuit of research work by the teacher is that he slights his class work and impairs his efficiency as a teacher. It must be admitted that the teacher often is tempted, during the prosecution of an interesting experiment, to "cut" his class, but, if research investigations are carefully arranged for certain definite periods of time, this temptation need not arise. At one institution, with which the author is familiar, the head of the department has arranged class schedules so that the instructors have one semester during which their teaching schedule is "heavy." The other semester as a result requires a minimum amount of teaching and the major portion of the instructor's time remains for research. Under such conditions the time of the man involved is devoted practically entirely to teaching for one term, and in the next, the greater portion of time is spent in research. Under such a system there is little temptation to neglect class work. A heavy teaching schedule and a large amount of investigational work being carried on at the same time is likely to produce unsatisfactory results in one or both phases of the work. The type of research must be such that no undue pressure shall be placed on the teacher. If results must be obtained at a certain time, and one falls behind, this pressure is likely to create conditions which will be undesirable.

During the term that a heavy teaching schedule is being carried, the spare moments of the teacher may be used in planning additional experiments or reading topics relative to the subject which is being investigated. Long experiments cannot be conducted, due to the fact that classes would interrupt and, in some cases, ruin the experiment. The planning and reading, however, may be interrupted without great inconvenience.

There is also the argument that research narrows a man's field of endeavor down to one or two individual problems. I question whether or not the teacher interested in research is going to lose his breadth of vision. For example, a problem in the field of enzyme action requires not only a knowledge of enzymes, but of organic, inorganic, colloid and physical chemistry. To be specific one of our enzyme problems led into a study of emulsions, osmotic pressure, imbibition, viscosity, hydrogen-ion concen-

[1] Should Teachers Do Research Work or Commercial Work? THIS JOURNAL, **1**, 222 (1924).

tration, conductivity, a study of molecular weight determinations, proteins, fats, carbohydrates and ash determinations with the subsequent analysis of the ash. Thus, the nature of this particular problem offered opportunities for the application of many phases of fundamental science. Again, a great deal of this information fitted into the course work which was being taught and enhanced the teaching, because part of the experimental procedure needed in the research problem would not have been used in teaching due to lack of appreciation of the nicety of the experiment.

It would seem that there is a chance for over specialization by the man engaged only in teaching. He may become so enthusiastic about pedagogy, psychology and organization that he will have the tendency to neglect classwork in that he does not have a thorough knowledge of his subject matter, to say nothing of the more recent developments in science.

Research, I believe, enhances the value of "book teaching" for several reasons. To perform laboratory experiments, it is necessary to be familiar with the technique involved. The teacher who reads, without having actual contact with the methods to be used in an experiment, is not going to be as well qualified to observe student work in the laboratory and criticise it as effectively as the teacher who actually works in the laboratory. Again, familiarity with methods is certain to enable the teacher to read experimental procedure with a critical attitude, and at the same time he will appreciate the method used by another investigator and realize that other methods may be better than his own. It is certain that students will respect suggestions offered by a man whom they know to be familiar with the details of laboratory technique, to a greater degree than suggestions from a man whom they see at a desk only.

In the performance of research work it is necessary to be familiar with recent literature, because of the many advances being made. One may say that the teacher doing no research spends part of his time studying publications which give results of recent investigations. This may be true, but is not his reading likely to be of a more perfunctory nature and without a real appreciation of the actual meaning of the data? Actual contact with a problem enables the scientific worker to better interpret results and fits him to take a more critical, yet appreciative attitude. The reading of this recent literature is stimulating and tends to create a desire for additional investigations and causes new questions to arise which demand solution. Much of the reading material may be used advantageously in advanced courses, the use of which causes a more appreciative attitude on the part of the student.

If we consider the teaching of chemistry in general, one duty is to teach facts and the other is to teach the student to think, but at the same time, it is necessary to interest and inspire the student. Let us assume that there are two men in the same department who are equally well trained, having

had about the same experience, and possessing good personalities. These men are teaching advanced courses and both are good teachers. One of the men, however, has been engaged in research and has a reputation as a capable research worker. Both offer advanced elective courses. To which man will the students go for their advanced course work? From the general observations of the author, the students elect work with the man who has the reputation, because the wide influence of this man appeals to and impresses the student. Is not this man of more value to the student, the department, the institution and the state than the teacher who does no investigational work? Of course the pedagogy and organization may suffer in the case of the research man, but his knowledge and experience overcome this handicap. In the case of men who are teaching freshmen or high school students, it is probably advisable for their entire time to be spent in teaching and in studying the difficult problems which arise in their work. It must be remembered that many good teachers are not interested in research. The question remains, however, as to whether or not research might not make these men even better teachers.

All science teachers recognize the value of research as an aid to humanity and as a source of new and up to date information. It becomes necessary for us to ask ourselves the question, "Where will our next generation of research men come from?" As teachers of science is it not our duty to our students to create interest and enthusiasm in the experimental phases of science? Will the student be able to catch that spark of research enthusiasm from the full time research man with whom he has no contact? Will the man who is a full time teacher create a desire for research on the part of the student? It is probable that neither man will tend to cause a student to become interested in research. Who, then, is to convey the "Spirit of Research" to the young men who are to become our future investigators, unless it is the good teacher who is interested in research and who is interested in several more or less fundamental problems?

THE COURSE IN HIGH SCHOOL CHEMISTRY. II.

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In the article by Miss Stephens on "A Plea for Interest,"[1] I am pleased to note that she agrees with some of my statements concerning the report of the National Committee on the "Reorganization of Science in Secondary Schools."

Miss Stephens, however, appears to have gained the impression that I am opposed to the introduction of useful and interesting material and that I consider it "lacking in educative value." I did not wish to give this impression. I thoroughly approve of making subjects both interesting

[1] *J. Chem. Ed.*, **2**, 141 (1925).

and useful, and believe that such information has a decided educational value, but this effort to make courses interesting and utilitarian has been carried to extremes. As a result other phases, which are of more real consequence in life after school days are over, are being sacrificed. I cannot agree with Miss Stephens that "education is the establishment of worthwhile interests," particularly when applied to primary and secondary education. This may be well enough for those who will have no special responsibilities to assume after leaving school. Most young men and women, however, after completing their secondary education, find it impossible to follow the lines of least resistance, though this is done altogether too frequently at present, and mainly because the school and home have failed to develop the ability to do otherwise. The primary object of precollege education should be to develop moral character, stability, good judgment, responsibility, respect for authority, stick-to-itiveness, endurance, self control, the ability to force one's self to do the things he does not want to do, etc., rather than to cram their heads full of interesting and possibly useful information. These are developed qualities rather than inherited qualities and are sacrificed when courses are so changed that they become primarily interesting and instructive and demand the least possible effort on the part of the pupils.

I agree with Miss Stephens that interest in literature is frequently injured rather than improved by the schools and that this is due largely to the uninteresting way in which the subject is taught. This, however, does not indicate a "failure in education" but a failure in the teaching of English. The primary object of English courses is to arouse an interest in the proper kinds of literature and it applies to every boy and girl; but a similar statement cannot be made about most of the other high school subjects as, for instance, chemistry, algebra, geometry, Latin, etc. I do not agree with the statement that "Unless our teaching of chemistry leaves the student with a desire to explore further than we are able to take him in an elementary course, it, too, is a failure." A course in chemistry, properly taught, should, in most instances, arouse an active interest in the subject, but this is by no means its principal objective. Is a course in Latin a failure if it does not create a desire to read more books in Latin after leaving school?

Miss Stephens questions my statement that a course in chemistry assists in the development of the qualities above listed. She remarks that "The statement needs proof." From my own experience in teaching, both high school and college chemistry, I am convinced that it should accomplish these things. The most convincing proof for me is, however, the fact that freshmen entering our colleges and universities at present are woefully more inferior in respect to these qualities than they were before the introduction of the present day ideas of professional educators concerning the methods of teaching and the subject matter of courses.

The changes in chemistry alone are, of course, not entirely responsible, but they come in for their share.

The colleges and universities are largely responsible for this condition. Their entrance requirements have been so weakened that many high school graduates are entering college who are not prepared to do the work. When subjects like domestic science, manual training, household chemistry, music, drawing, etc., are no longer accepted as entrance requirements, and there is a return to the old requirements of physics, Latin and more real mathematics, the question of freshman failures will be solved and high schools will again turn out real students. I believe the time is not far distant when a return to former conditions will be instigated.

NOTE: It may be of interest to the readers to learn that I have heard from many of the most prominent chemistry teachers and authors in the country in response to my article in the October number of THIS JOURNAL. So far they have all expressed their most enthusiastic support of the stand there taken. The question involved is one of the most vital ones confronting those interested in education. As with all questions, there are two sides, and I believe free discussion should be invited through the medium of the JOURNAL OF CHEMICAL EDUCATION.

A KINDERGARTEN SET FOR ILLUSTRATING THE DIATOMICITY OF THE FAMILIAR GASEOUS ELEMENTS

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It is, I think, not uncommon for students of elementary chemistry to find difficulty in comprehending the arguments leading to the conclusion that the molecules of hydrogen, oxygen and chlorine are diatomic. The mathematical derivation from Avogadro's law and the experimental observations made in the syntheses of water and hydrochloric acid are simple enough. Nevertheless it does offer difficulty to the beginner—perhaps because he is not sufficiently familiar with either the experimental facts or the law of Avogadro to reason confidently from them, perhaps sometimes because the textbook or teacher insists on drawing a narrower deduction than strict logic justifies—inferring that the molecule must contain *two* atoms, whereas the logical deduction is that it contains two *or some multiple of two*. A means of concrete illustration of the matter, which was suggested to me by my contact with agricultural students, is here described in the hope that it may be useful or suggestive.

Small, uniform, wide-mouthed bottles are used to represent equal volumes of the gases. Into each bottle is put a number of small pasteboard pill boxes to represent molecules, and into the pill boxes an appropriate number of seeds to represent the atoms. The chemical reaction is then represented by opening the pill boxes and rearranging the seeds, so as to represent the new molecules.

For example, to illustrate the argument for the diatomicity of oxygen, two of the bottles are labelled "Hydrogen." Into each is put (say) six pill boxes containing two hemp seeds. A third bottle is labelled "Oxygen" and provided with six pill boxes each containing two oats. Two more bottles are labelled "Steam" and each provided with six empty pill boxes. It is then explained that Avogadro's hypothesis and the experimental fact that two volumes of hydrogen and one of oxygen give two of steam are represented by the set of five bottles. The pill boxes (one from each bottle) are then opened and the seeds transferred from the hydrogen and oxygen pill boxes to those from the "steam" bottles. The student then readily comprehends that this redistribution would be impossible if the oxygen molecule contained only a single atom (or any odd number of atoms).

For the hydrogen chloride synthesis four bottles are required and corn is used to represent chlorine. The seeds were chosen so as to have the same initial letter as the element to be represented and an appropriate *order* of magnitude—oats larger than hemp (though unfortunately not nearly sixteen times as heavy) and corn larger than oats.

The bottles in our set are square glass-stoppered ones of the type known as "sugar sample bottles," the capacity being about 150 ml. The pill boxes are 18 mm. in diameter and 16 mm. in height. But the style and dimensions of the outfit may, of course, be varied according to taste and convenience.

CHEMISTRY IN MEDICINE

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Formerly chemistry and medicine were closely allied; indeed the term chemist is said to refer to the land of Chemi (Egypt) where the priests experimented with simple chemicals in the preparation of medicinal agents. Paraclesus in the 16th Century stated "The true purpose of the chemist is not to make gold but to prepare medicines." He introduced into medicine, mercury, lead, sulphur, iron, arsenic and copper sulphate, drugs still valued by the practitioner. However, the doctor and the chemist parted company and the chemist became an alchemist. Later he turned his quest for gold into the more successful direction of applied chemistry such as the making of iron and steel, and the manufacture of dye stuffs.

All life, vegetable, animal and human, is chemically dependent entirely on the chemical transformation of matter from that day when naked we enter life to that hour when we turn again to kindred dust. We are continually transforming carbohydrates, fats, proteins, salts and water into energy of one sort or another. Every motion we make, every breath we

draw, involves chemical combustion and change. This being so, it will easily be seen that the doctor must have as his partners the chemist and physicist, or combining them, the bio-chemist. The doctor understands and is the guardian of the machines. The chemist must assist with the question of fuels, of waste products, and of the materials necessary to prevent friction or effect repairs.

There is, of course, no more interesting chemical laboratory than the body itself; nor is there any other so complex. But of recent years great strides have been made, and chemists have analyzed the foods taken into this laboratory; have followed their various changes until at last they have been traced to their final transformation into energy, and the waste products have not only been analyzed but have been utilized as tests to determine whether or not the machine was functioning properly, that is, helping from the doctor's viewpoint to diagnose the condition of the machine.

To cite one of these various processes—it has been known for a long time that sugar was acted on by a certain group of cells in the pancreas, called the Islands of Langerhans after a German physician who first described them. When for any reason these cells were diseased or failed to work, sugar appeared in the urine; its value had been lost to the patient; the patient lost weight, grew thin, was liable to serious complications such as comas and gangrenes.

Banting, in Toronto, after a great deal of work, succeeded in treating the pancreas of animals in such a way as to promote the digestive action of the cells. This substance, Insulin, introduced into the body of a sufferer of diabetes turned the sugar into energy and averted the formation of those toxic substances which result when the sugar has not been properly metabolized.

This is one of the interesting ways in which biochemistry has taught us to substitute a healthy gland for a diseased, not by transplanting, but by capturing and utilizing the functional output of the cell.

Ehrlich found that certain dyes injected into the body had an affinity for certain cells. He conceived the idea that these dyes might serve as messengers to carry remedies to diseased cells or to carry murderous doses of poison to marauding foreign cells.

Syphilis is one of the oldest, most widespread and dreadful of diseases; protean in its symptoms and unscrupulous in its methods, it is caused by a small single-celled protozoan organism—the spirochete pallida. This cell turned out to be one of those that had an affinity for dyes, so Ehrlich handed to the messenger a lethal dose of arsenic, and the spirochete was heard of no more. This roughly is the famous 606, or Salvarsan, that has robbed the spirochete of its sting. By a similar drug, Bayer 205, the sleeping sickness of Africa can be cured, thus throwing a continent open to civilization.

Pasteur, a chemist, while studying fermentation, discovered the germs of suppuration. The discovery of germs had taken place at an earlier date, but he noted the resemblance between fermentation and the changes that took place in infected wounds. He applied his knowledge to improving wine-making, which had suffered greatly from the chemical uncertainties of fermentation but did not follow the lead into medicine; it was left for Lister to investigate this line. At first Lister and his fellow workers tried to find an antiseptic solution which would kill the bacteria. There were many solutions which would bring this about, but unfortunately when strong enough to kill the bacteria they were poisonous enough to damage or even kill the patient. A great many substances were tried; the chief one being carbolic acid or phenol, a coal-tar product that is also valuable in making explosives. None could be found, however, that was not open to the above objection. Surgeons then turned their attention to avoiding bacteria, by covering their hands with gloves, boiling their instruments, etc. This was called Asepsis—without septic germs—and was fairly successful. True an operation without any germs is not possible even if germs are excluded from instruments, hands, etc. They are still to be found in the air and in the skin and tissues of the patient. Usually, however, the protective germicidal quality of the blood is sufficient to cover this small number. Sometimes germs enter and multiply in the blood itself, a condition called blood poisoning and very difficult to control. Powerful antiseptics manifestly cannot be used. One of the meanest of these invaders is called the streptococcus hemolyticus. It is a germ which may come from the tonsils or air passages; having entered it proceeds to attack and decompose the blood corpuscles. Recently at Johns Hopkins, after a great deal of experimenting, there has been produced an antiseptic Mercurochrome, which may be injected into the blood—without fear of poisonous effects, and which is at liberty to pursue the streptococcus to the remotest parts of the body. Should it turn out to be efficient in the slaughter of streptococci while doing no harm to the body tissues, it will be a very welcome addition to the surgeons' armamentarum.

There is an interesting single-celled organism called the Amoeba, which usually finds access to the human body in impure drinking water. This cell is found in tropical or subtropical countries, but having received hospitable entertainment from a human host, has no objection to leaving his native land. Later, however, he usually makes his resentment felt by producing a chronic dysentery or a liver abscess in his host. Trotter, comparing this single-celled organism with man, the multicellular complex aggregation of cells, Godlike in complexity and functions, points out that man has not so far, been able to protect himself against this poor lowly amoeba, and says that if man does not take more thought unto

himself than he has hitherto, tireless Nature may sweep him—man—from her work table to make room for another of her interesting experiments.

Well, the chemist has removed part of the stigma, for at the least touch of emetine, the active principle of Ipecac, the amoeba shrivels and is no more. Sometimes, however, the amoeba digs himself in, entrenches himself in the mucus membrane of the large intestine and cannot be reached by emetine—then the physicist is called in. An X-ray battery is played on the abdomen, a counter attack is made from the inside of the colon, and the amoeba succumbs.

But, in addition to the messenger system of Ehrlich and the substitution system of Banting, where the product of a healthy gland of one animal is made to do duty for a diseased organ in another, the chemist is using the body itself as the retort or better the Alembic—for here we are close to the Marvellous—in which to distil some of the most potent and specific cures, for example, the antitoxins, vaccines, sera, etc. Some of these agents are curative, some confer immunity and some have diagnostic value. Their story is fascinating, hopeful but long, and can only be touched on in a most elementary way.

Briefly, the blood when it is attacked by invading cells, vegetable or animal, has the power of producing certain substances which oppose these cells, called antitoxins. If the blood produces enough of these the fight is a short one and soon ends favorably. If the opposing forces are evenly balanced, the fight may be long and the outcome uncertain. If the production of antitoxin is not adequate, death results.

In some diseases, for example, diphtheria, the horse may be called on to furnish the antitoxins. The virus (toxin of diphtheria) in a small dose, is injected into the horse; his blood responds by making antitoxins; the process is repeated, increasing the dose gradually and increasing correspondingly the production of antitoxins. By administering the virus to the horse gradually, he stands without any ill effects quantities which, if given at once, would probably be fatal. Then his blood, filled with antitoxins of diphtheria, is withdrawn, properly treated and injected into the suffering human with an effect so potent and favorable that diphtheria, once an awful scourge, is dreaded scarcely at all. In this way diphtheria and typhoid fever have been conquered, and scarlet fever has been or will soon be overcome.

Cocaine is one of the most valuable of drugs in producing local anaesthesia. It is, or was, derived from the coca leaf. So important is it that some one, perhaps the late Dr. Osler, said that a discovery of equal value did not occur in the profession oftener than once in every half century. But the original coca contained substances that were dangerous and sometimes caused death. The analytical chemist took cocaine to pieces, found out what was valuable and deleterious, and the synthetic chemist built up other substances containing only the valuable part of the molecule, without

any of its dangers, producing eucain, novocaine, apothecaine, etc. This synthesis of drugs is one of the most hopeful.

Further, the doctor and the chemist, or more particularly, the bio-chemist, have devised or discovered cures for leprosy, epilepsy, hook-worm and cures or relief for a great number of other conditions. There remain, however, several very important diseases to conquer; among these are tuberculosis, pneumonia and cancer. I speak of the last because I am more familiar with it.

Cancer is an overgrowth of cells, a riotous mob of cells that refuse to obey the restraints which all respectable normal cells observe. There is no new variety of cell, no cell that is not found in the body somewhere. For this disease, which takes annually a toll of about one hundred thousand lives, there is, generally speaking, no cure but the knife and radium, neither of which is satisfactory. If seen in the early stages, many of them remain localized and are removable with the knife; usually they are neglected until they have spread far beyond the possibility of removal or cure by any other means known to us at present. The microscope has probably told us as much as it can of the morphology or structure of cancer, but it only goes as far as the cells. Chemistry goes much beyond this, "for within the boundaries of even a minute cell there are dozens of different principles, myriads of molecules which defy the power of the finest optical instruments but yield their secrets to the patient analytical and synthetic quest of the chemist. There is a constant molecular interchange between the cell and its environment. Cell secretion, cell respiration, cell nutrition, are clearly only different aspects of the same kind of molecular activity." (Haldane.)

Patient chemical investigation seems the only method, or to be a part of the method which will cause cancer to yield up its secrets; and, having Pasteur, the chemist, in mind, I confidently look for the solution of the cancer problem from bio-chemists and not from a medical man.

The need for closer coöperation between the chemists, pharmacologists, biologists and physicians is then obvious and great. Five centuries elapsed between the discovery of ether by chemists and its application by doctors to the relief of pain. Even this omission, serious as it is, is not so important as the collecting and coördinating of effort among these various lines of scientific endeavor, in order that problems may be properly approached and quickly solved. Ehrlich worked 30 or 40 years over the cure of syphilis, until a generous contribution enabled him to collect the necessary investigating personnel, and satisfactory results were soon attained.

I have mentioned only a few of the many ways in which chemistry is aiding medicine, and pointed out several problems that call for immediate solution. These and many others will undoubtedly be solved when their importance is realized and a greater proportion of energy of the chemical profession is brought to bear on their solution.

UTILIZING RECORDED CHEMISTRY

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The date of the dawn of chemical literature, as we now know it, may be taken as the time when Robert Boyle and his associates of The Invisible College brought about the formation of the Royal Society in England. There, about 1665, we find the first systematic recording of scientific papers and discussions, and a careful preservation of the contributions for posterity under the name of the Philosophical Transactions of the Royal Society. A simple beginning it was; but now the practice is so universal and the contributions so numerous, that one is amazed to find more than one thousand periodicals publishing information more or less closely related to the work of the individual in chemical and related pursuits.

The record of known chemical facts and the theoretical discussions involving them, even when limited to the century and a half since the fundamental work of Lavoisier, presents an impressive collection as viewed in a fairly complete library of chemistry. To this existing collection there is added annually a constantly increasing volume of material.

Instructors in chemistry are not alone in the realization that it is futile to overcrowd the curriculum with specialized, technical courses involving chemical or other facts. We can detect in a recent announcement of the School of Medicine of Cornell University a trend towards a more liberal and broader basic plan of study. From one of the administrators of this institution comes the statement that we should prefer having game birds which know how to find their own food rather than fowls fattening for the market which expect their food to be served to them in trays. He warned a class of incoming students that, "the best that we can teach you now will be hopelessly inadequate in another decade. You must teach yourself to study the medicine of this decade in such a manner that you can teach yourself the medicine of the next decade. You must learn to do your own searching for knowledge. You must develop your own powers of observation and critical judgment. You must learn how to use the literature and must prepare yourself to substitute your own wards, your own laboratories, and your own libraries for those of this medical school."

One agrees with Barrows that, "chemical literature is the storehouse of the available published information of chemical science and chemical industry." Such a storehouse—the permanent memory of the chemist—can be opened only by those who have become acquainted with its contents. One must know something of the searcher's technic. In fact, so dependent are we upon the accumulated information of the past that Libby well concludes, "very little advance in culture could be made, even by

the greatest man of genius, if he were dependent for what knowledge he might acquire upon his own personal observations. Indeed, it might be said that exceptional mental ability involves a power to absorb the ideas of others, and even that the most original people are those who are able to borrow most freely."

With the conviction that a student trained in courses broad and general in character rather than narrow and detailed should then know something regarding the arrangement and contents of this storehouse of recorded chemical facts. There has recently been introduced in a few universities required work involving the study and use of this material. The author believes that such training should be designed to acquaint the student at least with the origin and development of the literature of value to the chemist and chemical engineer; with the character of the information to be found in such sources as periodicals, patents, indexes, handbooks and treatises, dictionaries, monographs, Government bulletins and other publications pertaining to chemical subjects; and with the use of such sources of information.

The question regarding a suitable method of instruction arises. Like many other activities, actual experience is the most valuable teacher. One might spend hours discussing the details of some compilation, but the student will become really familiar with the work only by direct contact with it. Some discussion and explanation seems desirable, but practical assignments to be worked out in the library are essential.

The material considered in the classroom will vary with the training and viewpoint of the instructor. The amount and variety must be adjusted to the time available. A suitable outline may be formulated from the pamphlet of Miss Sparks,[1] taken along with such papers as those of Barrows,[2] Hibbert,[3] and Hamor.[4] Perhaps the most important discussion should center on the types of chemical literature, including a consideration of the contents and method of compilation, and the proper method to follow in searching for desired information. As suggested by Hamor, the discussion may be expanded to include such phases of the subject as the production and recording of the material, the technic of the librarian, and the methods of writing and abstracting.

In making assignments to the library one may select a section of suitable length from the general outline. It is, of course, highly desirable to give each student an individual assignment. This may be accomplished without an undue amount of work by the instructor by using blank forms such as that shown here.

[1] Chemical Literature and Its Use (1921).
[2] *Chem. Met. Eng.*, **24,** 423, 477, 517 (1921).
[3] *Ibid.*, **20,** 578 (1919).
[4] Special Libraries, April (1923).

CHEMICAL LITERATURE

Library Problem No. 5

In the compilations indicated (Author—title—volume—page—date) one may find the designated physical constants for the substances noted.

1.—.....
Sp. G.....M. Pt.....B. Pt.....
.....
2.—.....
Soly. in.....at.....C°.....
Investigator.....Orig. Ref.....
.....
3.—.....
Sp. G.....Iodine No.....Refr. Index.....
Solidifying Pt.....Hehner value.....
Optical rotation.....Sapn. value.....
.....
4.—.....
Heat of solution.....Heat of formation.....
Specific heat.....Heat of combustion.....
.....
5.—.....
Sp. G. (Density).....Elec. Cond.....
Vapor tension.....Refr. Index (.....line).....
Viscosity.....Surface tension.....
.....
6.—.....
Dissociation constant at .....C°.....
Solubility product at .....C°.....
Investigator.....Orig. Ref.....
.....

This particular one was designed for the assignment covering the various works containing compilations of physico-chemical constants. The name or formula of the substances assigned for the various parts is written on the first blank line in each case, indicating any special conditions, such as temperature. In parts 3 to 6 a check mark is placed at the particular values desired. The student indicates on the dotted line the source of the information, including in two of the six parts the name of the investigator making the determination and also the original journal reference where the details of the work may be found. The latter requirement necessitates the use of a work like the "Tabellen of Landolt-Börnstein."

Having completed the shorter, special assignments on the various types of literature, the author gives, as the final assignment, the compilation of a bibliography on some specified subject. This subject must be carefully selected to give the desired training in the time available. The compilation of an accurate and complete bibliography on the scientific study of amalgams, for example, requires weeks if one goes through the indexes and then reads all the articles thus located in order to ascertain whether the refer-

ences included in each of these are relevant to the subject being investigated. On the other hand, the literature on "anti-knock" materials is still comparatively meager. The bibliography may be limited by specifying some definite interval of time to be covered, or by requiring only the references found in certain places, as those listed in the index of *Chemical Abstracts* during the last ten years.

A TEXAS HIGH SCHOOL SCIENCE SURVEY

REPORTED BY THE SOUTHWESTERN CHEMICAL SOCIETY, J. B. ENTRIKIN AND F. C. HODGES, COMMITTEE

High school students entering the higher institutions of learning in Texas do not receive advanced standing in work done in the sciences in the high schools. If they wish to take more science in the college or university they must, in almost every case, start with those students who have had no high school science. This leads naturally to the inquiry, is science in public secondary schools keeping pace with the rapid development of science in the world at large? Is the school, the place where young people are taught how to live more fully, really preparing the students for this large group of realities with which every one is constantly confronted, and with which a large portion of our people spend their working years? These questions naturally arise among those interested in teaching a science. Since there was no available data on the status of science in the high schools of Texas a survey was attempted of these schools. The work was attacked from a chemical standpoint, since the survey was conducted by people interested particularly in chemistry.

Under the supervision of Prof. J. C. Godbey, head of the Department of Chemistry in Southwestern University, the class in the "Teaching of Chemistry" of that Institution, made a survey of the high school chemistry students. Information was wanted regarding the number of students studying the sciences, the science requirements for graduation, the method of presentation of chemistry, and the qualifications of the instructors of chemistry. A questionnaire covering these questions was prepared, the State Department of Education was very courteous and desirous of aiding the survey in every way possible. Much information was tabulated from the files of that office. A questionnaire covering unanswered questions was sent out to the two hundred and twelve high schools of Texas that were affiliated in chemistry during 1924. A personal letter was written to the superintendent if a reply was not received at once. One hundred and forty-seven, or 70% of the schools returned the questionnaires. However, some schools did not answer all the questions, hence the tabulated data varies as to the number of schools covered.

One hundred and twelve schools answered the question, "How much science is required for a high school diploma?" The results are:

32% require no science for graduation.
33% require one year of science for graduation.
28% require two years of science for graduation.
7% require three years of science for graduation.

The schools were divided into four groups according to the enrollment in high schools, as follows: (1) schools having less than 250 students, (2) those having between 250 and 500 students, (3) those having between 500 and 750, and (4) those having more than 750 students. The percentage of students enrolled in chemistry, physics and biology was calculated. This data shows the percentage of students taking science, and the relative popularity of the three sciences. It must be remembered that questionnaires were sent only to schools that were affiliated with chemistry. This data includes 31,113 students from 109 schools. Only five schools reported general science, with an enrollment of 382 in the subject.

School group	School enrollment	Chem. enrollment	Percentage
CHEMISTRY			
Above 750	7376	699	9.5
500–750	6293	450	7.3
250–500	7999	755	9.4
Under 250	7894	1213	15.4
Total	29,562	3117	10.5
PHYSICS (PHYS. EN.)			
Above 750	7376	331	4.5
500–750	4384	144	3.3
250–500	6871	361	5.3
Under 250	6417	871	13.6
Total	25,048	1707	6.8
BIOLOGY (BIOL. EN.)			
Above 750	4776	398	8.3
500–750	3177	223	7.0
250–500	6369	592	9.5
Under 250	3993	821	20.6
Total	18,315	2034	11.1

Thus 6858 students out of the enrollment of 33,113 were taking at least one science during the year. This is only 22%.

Very meager reports were made as to the grades in which the various sciences were taught. In many schools they vary from year to year, while in others, two sciences are taught in the same grade on alternate years. Only eighteen schools were reported as teaching all three sciences. Biology was offered in the sophomore year in all of these, and chemistry came during the junior year in fifteen of the eighteen. Sixteen other schools

reported both physics and chemistry, and of these, fourteen offered chemistry in the junior year.

The reports show that the time devoted to organic chemistry, as a part of the general chemistry, varies from one week, or less, in most schools, to one month in a few schools.

One hundred and twenty-one schools gave information on the subjects taught by the instructors of chemistry. These show the following results:

Full time devoted to chemistry	23%
Time devoted to chemistry and physics	19%
Time devoted to sciences	43%
Chemistry teachers who also taught subjects other than sciences	15%

Reports were available on the time spent in college by 177 teachers.

Holders of M.A. degree	8
Holders of A.B. degree	116
Without degree, but having spent five years in college	6
Without degree, but having spent four years in college	9
Without degree, but having spent three years in college	25
Without degree, but having spent two years in college	12
Without degree, but having spent one year in college	1

The data is not so extensive regarding the preparation in chemistry of each teacher, since reports were received from only one hundred and sixteen, and some of these were slightly vague as to the course taken. The following data gives an idea of the preparation in this subject.

Students of inorganic chemistry	116
Students of inorganic and qualitative analysis	107
Students of inorganic, qualitative and quantitative analysis	41
Students of inorganic, qualitative and organic chemistry	64
Students of all four	38

CONCLUSION

While this report is far from complete on Texas high schools, it covers a great number, and should, therefore, be of value in judging the conditions in general. It is probable that the schools not reporting would have less satisfactory results on the average.

One third of the schools require no science whatever. The situation is even more regrettable if we notice that only 22% of the enrolled students were taking any one of the three science courses. No other science course was reported with sufficient numbers to justify its consideration. If we consider last session as an average one, and it must have been, we see that less than one out of four students in high school is getting even an introduction to any of the natural sciences. This seems deplorable when we consider how much these subjects contribute to the general intelligence, an appreciation of nature and her processes, and the potential training

of the individual. The scientific spirit of searching for facts impersonally, regardless of the field of endeavor, needs to be developed in every student. The natural sciences are most adaptable for this purpose.

It is noticeable that the smaller schools have nearly twice as high a percentage of science students as the larger schools. Certainly the large town and city child should know the principles of science. Public sanitation, social studies, individual interest in industrial usages from merely a cultural standpoint, and the probability of practical application should lead the majority of students into science courses. Heredity and environment determine the man to a great extent and the sciences deal with both of these factors.

Too little organic chemistry is offered in the chemistry course. Surely the chemistry of foods, cloth manufacture, fuels, dyes and medicines deserves more than two or three lessons. The student cannot fail to be interested and instructed if these subjects are presented in a proper manner.

Fifteen per cent of the chemistry teachers are teaching some subject other than science. The greatest efficiency cannot be obtained in this way. The sciences are inter-related, and can all be handled, if need be, without much loss of specialization, but a teacher should not be expected to specialize in two entirely different fields.

The great majority of the chemistry teachers last year were degree holders, and many more were approaching that standard. This is very good. However, the preparation in chemistry does not show as favorably. No teacher can be prepared to develop chemistry properly to a high school student unless he has a very clear understanding of inorganic, organic and some analytical chemistry.

For the development of the scientific spirit among our high school students, we wish to suggest the following:

1. The requirement of two years of science for graduation.
2. The stimulation of reference reading and plant observation by the students of science courses.
3. The requirement of sufficient science preparation for science teachers.
4. Minimizing the teaching of other subjects by science teachers.
5. The organization of science clubs, in regular meetings, for the discussion by students, and visitors, of scientific problems and observations.

NEW JERSEY CHEMISTRY TEACHERS' ASSOCIATION

A committee has been appointed and has plans practically completed for the formation of a Chemistry Teachers' Association as a Section of the New Jersey Science Teachers' Association. This idea is meeting with hearty approval by the New Jersey teachers.

SOME NEEDED IMPROVEMENTS IN CHEMISTRY TEXTS

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The perfect high-school text in chemistry has not yet been written. It may never be written. It can be argued that it never can be written for the reason that chemistry is growing so rapidly, is undergoing so many developments, and finding so many new applications in new fields that any book which is adequate today must tomorrow be relegated to the shelf of discarded texts. From the descriptive standpoint this is probably true. But there is danger, that, in the endeavor to make their text up-to-date, the authors may present inadequately those fundamental principles upon which any clear and consistent knowledge of chemistry must always rest. Such presentations should not only be clear in themselves, but should be cast in such form as to avoid confusion on the part of the young student.

It seems to me that our recent texts have not paid sufficient attention to the question of avoiding confusion of ideas, and of clinching them by repetition and by other devices. Among other items in the account let me mention uniformity in mathematical presentation, accuracy in definitions, suitable comparisons of certain elements and compounds, and stress upon general principles.

Uniformity. Take down from the shelf of your reference library, if you please, several recent chemistry texts and jot down the different forms found therein for the expression of the laws of Boyle and Charles in formula form. I find these.

$$\text{I } \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}, \quad \text{II } V_1 = \frac{V(273 + t_1)P}{(273 + t)P_1}, \quad \text{III } P_1V_1T_2 = P_2V_2T_1,$$

$$\text{IV } V_2 = V_1 \times \frac{P_1}{P_2} \times \frac{T_2}{T_1}, \quad \text{V } V = \frac{P \times Vt}{760\ (1 + 0.00366)t}, \quad \text{VI } V = \frac{P_1V_1}{760\ (1 + 0.00366\ t)}.$$

Right here some chemistry teacher will say: "Why, these are only different forms of one equation and any one of these can easily be changed to any other." Yes, of course they can, and to you as a teacher of some years of experience in going over the ground annually the step would be easy, but how about the not over-studious youngster who is going over the ground for the first time? If he has had physics in his previous year, as is often the case, he will doubtless have been taught to use some one of these formulas. Is the formula given in the text in use in your class the same as the formula in his last year's physics book? If, by reason of a change of residence and consequent transfer from one school to another during the middle of the year, he comes to you with some familiarity with one formula, shall you expect him to lay aside that one and confuse him by giving him another, even if you can point out that there

is really no difference. There are many pupils to whom even such a change proves to be a stumbling block. Why should there not be some agreement among the publishers of science books so that there might be some approach to a uniform method in such cases?

Again, there is little uniformity in the arrangement of work in the solution of stoichiometric problems. Take the following problem and note the differences in the method of solution.

PROBLEM: How many grams of zinc are needed to make 30 grams of zinc sulphate?

I $\underset{65}{Zn} + \underset{98}{H_2SO_4} \longrightarrow \underset{161}{ZnSO_4} + \underset{2}{H_2}$

$65 : 161 :: x : 30$

$x = ?$

II $\underset{65}{Zn} + \underset{x}{H_2SO_4} \longrightarrow \underset{161}{ZnSO_4} + \underset{30}{H_2}$

$\frac{x}{65} = \frac{30}{161} \quad x = ?$

III $\underset{65}{Zn} + \underset{98}{H_2SO_4} \longrightarrow \underset{161}{ZnSO_4} + \underset{2}{H_2}$

$\frac{65}{161} \times 30 \quad x = ?$

IV $\underset{65}{Zn} + H_2SO_4 \longrightarrow \underset{161}{ZnSO_4} - \underset{30}{H_2}$

$\frac{65}{x} = \frac{161}{30} \quad x = ?$

In Method I we have the use of the old-fashioned proportion which is out of date in the textbooks on mathematics; why should it be retained in chemistry? Methods II, III and IV, while not actually differing from a mathematical standpoint, do differ in form and it is this difference in form which may confuse the student who is switched from one school to another or from one book to another. Why should not one standard form be used in all problems of this type?

When I speak of *accuracy* I do not refer to the descriptive matter in the text, but to the definitions. For example, the student reads: "An acid is a substance which gives hydrogen ions in water solution." This statement seems all right and is easily verified by experiment. All acids are found to have a common taste, to affect indicators in the same way, and to neutralize bases to form salts, and these properties are due to the common hydrogen ion. The student soon finds that other substances like sodium bisulphate have the same or similar properties, but he is told that such substances are not acids. It now appears that there is something wrong with the definition. It was good so far as it went, but it did not go far enough. Should not an acid be defined as "a substance whose only positive ion in water solution is hydrogen" or as "a substance which gives hydrogen ion in water solution and no other positive ion." This readily distinguishes an acid from an acid salt. The same inaccuracy of definition is found with reference to bases.

Has anybody a satisfactory definition for valence? Alexander Smith says "It is certainly not the combining power of an atom."

Should an indicator be defined as a substance which changes color in the presence of an acid or a base? Should it be defined as a substance which shows by color change the presence of hydrogen or hydroxyl ion? The latter seems to me preferable. In cases of hydrolysis, such as is seen in water solutions of borax or of washing soda, although no acid or base is originally present, it is the hydroxyl ions formed which cause the phenolphthalein to turn red.

It seems to me that more careful attention should be paid to the matter of accurate definition of chemical terms. The ones mentioned are only a few of those which come to mind.

Comparison is one of the most instructive methods of teaching the chemistry of substances which react in similar ways. Sulphur and oxygen, carbon dioxide and sulphur dioxide may thus be studied and their various reactions compared or contrasted. Take, for example, the action of concentrated nitric acid and concentrated sulphuric acid on copper. Both substances act as oxidizing agents. Here are the comparative equations:

$$
\begin{array}{ll}
2HNO_3 & \longrightarrow H_2O + 2NO + 3O \\
3Cu + 3O & \longrightarrow 3CuO \\
3CuO + 6HNO_3 & \longrightarrow 3Cu(NO_3)_2 + 3H_2O \\
\hline
3Cu + 8HNO_3 & \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O \\
H_2SO_4 & \longrightarrow H_2O + SO_2 + O \\
Cu + O & \longrightarrow CuO \\
CuO + H_2SO_4 & \longrightarrow CuSO_4 + H_2O \\
\hline
Cu + 2H_2SO_4 & \longrightarrow CuSO_4 + SO_2 + 2H_2O
\end{array}
$$

We see how closely the equations run parallel. In both cases, a salt of the metal, water and an oxide of the middle element in the acid are formed. Many other similar cases will doubtless occur to the reader. But I do not recall any text which makes such comparisons.

General principles. Look up, if you please, in some half dozen chemistries, the method given for the preparation of ammonia. You will probably find it generally stated that ammonia is prepared by treating ammonium chloride with calcium hydroxide. The statement is perfectly true. The student learns the statement and believes that ammonia can only be made by this method, since no other method is given and no general principle is enunciated.

Now just for fun suppose you grind together in a mortar a little moist ammonium sulphate with some solid sodium or potassium hydroxide and note if ammonia is liberated. Try ammonium oxalate with barium hydroxide. Try all combinations of an ammonium salt and a base. Given six ammonium salts and four non-volatile bases, how many ways can you make ammonia? Can you not evolve a general principle? Have you ever seen that principle emphasized in any high-school text?

Similarly a general principle underlies the preparation of the common

acids, the manufacture of water glass, and countless other chemical reactions, but those general principles are not stressed as general principles; they are not made to stand out in the text. Why shouldn't they be emphasized?

If I were asked to name the most valuable single teaching topic in chemistry I should be tempted to name the Displacement Series of the Elements. It is astonishing how much one can derive from it. The whole story of the occurrence of the metals as free or in combination is revealed by it; the general method of the metallurgy of the metal; the reactions likely to take place between the metal and water or between the metal and an acid can easily be derived from this series. If the student can once get so that he understands the meaning of the Displacement Series he will find it an enormous help in understanding the chemical actions of the various metals. How shall you make it clear to him why zinc is used for making hydrogen, but copper is not? In what way shall you explain the fact that iron will displace lead from solution but copper will not? Clearly the Displacement Series is the explanation. Whenever a new metal is taken up or a reaction studied in which a metal takes part, the Displacement Series should definitely be referred to until by a continued repetition of the idea it is finally driven home. But most texts allow a scant half page, perhaps, to the discussion of this most important point, and it is rarely referred to again throughout the rest of the book.

It appears to the writer that texts in chemistry might be much strengthened if more attention were paid to the points outlined above.

APPARATUS USED BY DR. MORLEY

W. SEGERBLOM, EXETER ACADEMY, EXETER, N. H.

In connection with a paper presented at a recent meeting of the American Chemical Society on "In and Out of the Class Room with Dr. Edward William Morley,"[1] Dr. Mears, of the Department of Chemistry at Williams College, stated that much of the apparatus originally used by Dr. Morley is now the property of Williams College and he invited all chemists interested in Dr. Morley's work and desirous of seeing some of the apparatus used in his historical experiments to call upon him at Williamstown at any time and an opportunity will be given to inspect this exhibit. Mr. Morley wisely decided to distribute his remaining books and apparatus while living. During the last years of his life he derived great pleasure and satisfaction in placing his library and other scientific apparatus among several colleges. As a loyal alumnus of Williams he naturally favored his own college in this distribution.

[1] THIS JOURNAL, 1, 129 (1924).

A SYSTEM OF LABORATORY INSTRUCTION IN ORGANIC CHEMISTRY

J. W. HOWARD, STATE UNIVERSITY, MISSOULA, MONTANA

The system described in this paper was first introduced to the author while he was an assistant to Dr. C. G. Derick at the University of Illinois. Dr. Derick had it worked out in a highly perfected form even to the recording of the results. This account of it is given from the viewpoint of nine years' satisfactory use as a teacher.

It can perhaps, best be described by reproducing a copy of the instruction sheet given the student, as follows:

The laboratory work in this course is divided into four parts.

First. The student is required to read over the directions and necessary literature in connection with each preparation and bring to the instructor, before the preparation is started, a *written* report, called a "preliminary report," containing the following data:

Date Title Name of Student

1 A list of the physical properties of all substances used and prepared in the experiment

2 The main reaction for the preparation (the equation being given in steps where possible)

3 The chief side reaction which might take place

4 Best experimental conditions, *i. e.*, mass relations; temperature control; method of mixing ingredients; precautions, etc.

5 Reasons for and reactions (if any) of method of purification used

6 Equations for two other general methods of preparing the same compound.

The responsibility for having this report approved before starting the experiment is placed upon the student.

Second. The apparatus "set up" must be checked before proceeding with the experiment.

Third. The finished product must be turned in suitably labelled and in acceptable form, in order to receive complete credit.

Fourth. A "Final Report" containing this data:

Date Title Name of Student

1 Brief description of experiment

2 Report of yield and calculation of % yield

3 Two typical reactions of the compound prepared.

Two methods of recording the work in note books have been tried by the author. In one a bound note book was used, writing the "preliminary report" on the left hand sheet and the "final report" on the opposite right hand sheet. In the other loose leaf paper was used. The latter is preferred in that the instructor can retain the reports and hence stop the circulation of approved reports among the students.

Obviously the system best adapts itself to a course where the main experimental work is preparations. If these preparations are so selected that each represents a class of compounds the written work gives a very good review of that class.

The preliminary report prevents one of the most common faults of laboratory instruction, allowing the student to grind through a lot of work and *then* go to the literature to find out what it was all about.

The checking of the "set up" not only insures the actual doing of the work on the part of the student, but is a wonderful preventative against careless manipulation.

Time is allowed in the laboratory period for the writing of the reports. While this cuts down somewhat the number of preparations that can be done, we believe it is a good sacrifice of quantity for quality. The student is encouraged to get several preliminary reports ahead and so plan his work that the loss is not as much as might be expected. We require that no student be back with more than three finals at any one time, and thus keep the notes "hot."

If the class is small (eight or ten students) the instructor can give individual oral quizzes on both reports. With a class of fifteen this can be done with the preliminary report only. A class of twenty to twenty-four can be handled by simply checking the reports and omitting oral quizzes. The different rates at which students work has been found to be such that there need be very little loss of time on the part of the student waiting his turn to have his report approved.

We will have to admit that this system "works" the instructor as well as the student, but the satisfaction in the results well repays the additional effort.

A DEMONSTRATION EXPERIMENT OF ELECTROLYTIC OXIDATION AND REDUCTION

C. E. WHITE, UNIVERSITY OF MARYLAND, COLLEGE PARK, MARYLAND

Pour a sufficient quantity of gelatin solution containing 1% NaCl into the bend of a U tube so that the two arms will be separated. Cool the gelatin to solidify it. Place a very dilute solution of ferric chloride containing a little potassium thiocyanate in one side of the tube, and a ferrous chloride solution of a like concentration, also containing potassium thiocyanate, in the other side. The ferric chloride should be only sufficiently concentrated to give the characteristic red coloration with potassium thiocyanate. Platinum electrodes should be used. When the negative pole is placed in the ferric chloride and the positive pole in the ferrous chloride solution, in a short time the ferric ion will be reduced to ferrous and the ferrous ion oxidized to ferric. The colors of the solutions will now

be reversed; the blood red (showing ferric ions) will appear at the anode and the colorless (showing absence of ferric ions) at the cathode. The time required for the reaction to take place will of course depend upon the strength of the current and upon the strength of the solution.

THE APPLICATION OF THE SLIDE RULE TO CHEMICAL CALCULATIONS

PROF. W. T. GOOCH, BAYLOR UNIVERSITY, WACO, TEXAS

The Slide Rule is adapted to many computations and for approximate results is valuable on account of the time saved. The accuracy is sufficient for almost all practical requirements and this is especially true of elementary chemical calculations. The methods and instructions for operating the slide rule are furnished with the rule and will not be repeated here. However, a scheme for its use in working gas problems rapidly will be given for the aid of those who may care to apply it. The author is a strong advocate of the slide rule in teaching chemistry calculations and checking students' work and has found it great help in the class room demonstration of chemical problems.

In working proportions, as for example 38.6 : 77.2 :: 4.7 : x, the first and third terms are set on the D scale and over them on the C scale, the second and fourth terms. Thus the value x would be found on the C scale over the third term 4.7 if the second term 77.2 is set over the first term 38.6.

Diagram:

C	Set 77.2	Read x
D	Over 38.6	Over 4.7

In working the problems involving the application of Boyle's and Charles' laws the methods of statement of each problem as outlined in Type I must be made first as

$$453 \times \frac{732}{760} \times \frac{273}{285} = V'$$

$$V \times \frac{P}{P'} \times \frac{T}{T'} = V'$$

Let the three numerators in the statement be designated by V, P and T, respectively, and the denominators by P′ and T′. Then the steps in the calculation are as follows: Set V on the D scale and over it set P′ on the C scale. Then move the runner to P; next move the slide until

T′ is under the runner; then move the runner to T, and under that on the D scale read the result V′. This may be diagrammed in this manner:

C	Set P′	Runner to P	Slide T′ to runner	Runner to T
D	Set V			Read V′

Thus all the volumes are found on the D scale and the temperature and pressure factors on the C scale. The author's slide rule has the positions 273 and 760 marked on the C scale and the position 22.4 on the D scale with red ink. The author has been able to find the result of a problem like that given above in less than twenty seconds with the slide rule. —P. 26 from "Typical Calculations in Elementary Chemistry," by W. T. Gooch. Baylor University Press, 1923.

ABSTRACTS OF PAPERS TO BE PRESENTED AT THE BALTIMORE MEETING OF THE AMERICAN CHEMICAL SOCIETY, APRIL 6-11, 1925

Systematic Treatment of First Year Chemistry. P. M. GLASOE. Approach the subject through familiar channels. Do not swamp the student with new definitions and new vocabulary from the start. Have student name a list of all the metals and non-metals he knows from every day life. Carry the process forward by having him arrange the elements as found in a table of atomic weights in the order of their weights. Fifteen or twenty metals with half a dozen non-metals constitute a year's work. Arrange first two series: Li—Ne and Na—A so as to show grouping. Study, by means of these series, the change of properties from metallic to non-metallic, positive to negative, basic to acid. On the same basis take up chemical affinity, valence, structural formulas; acids, their derivation and structural formulas, bases, their derivation and structure; salts, their structural formulas and relative stability; the derivation and properties of the anhydrides of both bases and acids. Amphoterism is a natural deduction. Elements are studied in the order of their occurrence in the groups of the Periodic System.

The Art of Lecture Table Demonstrating. HERBERT F. DAVISON. Lecture table demonstrations are worth while because they make the subject concrete. Chemistry as usually taught, is, to many students, a very abstract thing, but well chosen, deftly performed experiments can make the subject very real to such students. Demonstrations should not be performed simply because they are spectacular, but because they teach a chemical lesson. The building of apparatus which above all should be simple and capable of expeditious exhibition, gives the teacher himself the kind of mental stimulation needed by those who teach the general chemistry. It is better to show no experiments on the lecture table than to have any appreciable percentage of failures. A number of experiments will be performed to illustrate the principles discussed.

Correlation of High School and College Chemistry. LEROY L. SUTHERLAND. A discussion of the true function of a High School Chemistry Course as to purpose and scope. A plea that colleges and universities exercise greater caution in accrediting the science work of secondary schools. An exposition of the harm done to both chemistry and the individual student when, on entering Freshman chemistry, he is given no recognition whatsoever for work done in his high school course, but told to "*Forget all you have learned—we will now teach you correctly.*" A claim that the study and teaching of chemistry should be a *progressive growth*, and not a planting of seed which as they begin to sprout are ruthlessly torn up and cast aside on the dump-pile to be replaced by more—SEED. This represents lost motion. We must see to it that the secondary schools plant the *right kind of seed*, and then build to but not destroy their work.

Teaching the Growth of Chemistry in Industry by the Use of Maps. LOUIS W. MATTERN. From reports compiled by Professor Charles E. Munroe, Expert Agent in charge of "Chemicals and Allied Products" at the U. S. censuses 1900–1905–1910, several charts were prepared which he used during the course of an address, published in the January, 1925, issue of THIS JOURNAL, to show the growth of several chemical industries

and the need of their extension into unoccupied fields. These charts are very instructive so it has been suggested that the large body of important census statistics of chemical industries since 1900 could be used in producing a system of charts, by means of suitable characters on maps of the United States, which would clearly visualize the growth of chemistry in industry and the vast areas of latent resources which challenge chemistry to greater service. Such maps would prove most useful to teachers. Acting on the belief of the importance of this work, the author has conferred with Mr. William W. Stuart, Director of the Census, on the feasibility of this matter and who expressed his desire to furnish maps of intervening censuses.

The Problem of High School Chemistry. GUY CLINTON. The three principal factors recognized are: matter, arrangement and method. The paper is restricted to the discussion of the latter two. One fundamental principle which determines arrangement is that matter should be presented in a progressive order, so that that which follows may not presume knowledge beyond what the preceding exercises give opportunity to learn. It is considered preferable to build a course around laboratory experiments rather than to take it from a textbook. Experiments should be grouped about principles rather than principles about experiments. The language of chemistry should receive the particular attention of teachers.

Museum Experiments. R. A. BAKER. Any reaction which requires considerable time for completion, or which is of such a nature that its course is automatically recorded, may be utilized as a "museum experiment." The set-ups may be displayed long enough to attract general attention, and when properly placarded, stimulate interest and profitable discussion among students. A number of appropriate experiments are described.

The present Status of the Ionization Theory. JAMES KENDALL. The original ionization theory, as formulated by Arrhenius, is unable to account for the most important type of all conducting solutions—strong electrolytes in water. These do not follow Ostwald's dilution law, but do conform approximately, nevertheless, to the solubility product principle. It may be deduced from this that the stumbling-block is connected in some way with the undissociated molecule in solution. Recent research, indeed demonstrates that the Arrhenius conception of kinetic equilibrium between undissociated and ionized solute is incorrect. The extension of the ideas of the Braggs on crystal structure and of Lewis and Langmuir on atomic structure to solution leads to the conclusion that the undissociated molecule is practically non-existent, and that at high dilutions, electrostatic forces between oppositely charged ions are the prime factors to be considered. At greater concentrations, interactions between solvent and solute must be taken into account, and rules regarding such interactions have been qualitatively established. The collapse of the theory of Ghosh discredited "complete ionization" temporarily, but the more rigorous equations of Debye and Hückel are fully in accord with experimental data. Some points of difficulty still remain, but the rapid advances made in the last few years inspire the hope that the field will be entirely cleared up in the near future.

Use of Charts, Motion Pictures and Other Aids in the Teaching of Elementary Organic Chemistry. ALEXANDER LOWY. A number of charts, diagrams, such as "Products from a Barrel of Oil," "Products from a Hundred Tons of Coal," "Organic Type Formulas," "Organic Chemical Transformations," "Petroleum Refining," etc., will be shown. The use of motion pictures entitled "The Story of Petroleum" (4 reels, distributed by the Bureau of Mines) and "By-product Coking" (2 reels, distributed by the Koppers Company, Pittsburgh), will be emphasized. Saving time at lectures, by using colored crayons, will be illustrated.

Minimum Essentials: "Teach—Test—Reteach." RACHEL E. ANDERSON. The determination of a definite course of study to fit the existing needs of a high school where college and non-college preparatory students are taught in the same class. The adoption of definite minimum essentials to be mastered by all students; the effective and rapid measurement of them to determine whether reteaching is necessary for the individual or the class collectively. The experiment has proved the effectiveness of teaching for mastery, rather than for distribution along a normal curve. In fact the application of the method of "Teach—test—reteach" has developed a mastery of fundamental principles that has made the curve of distribution top-heavy on the positive side. The plan breeds a closer correlation between laboratory and textbook assignment and the use of reference books. Furthermore the plan is not complete until chemistry is built into every day processes. Slosson's Creative Chemistry is read and the rather pleasant game of one hundred "false and true" questions measure the results. Chemistry has increased in popularity and there has been a marked decrease in the number of failures.

Chemical Digest

ABSTRACTS

Why Not Save a School Year? (Editorial.) *High Sch. Quart.*, **13**, 65–9 (Jan., 1925).—The eighth grade of the grammar school is largely a year of lost motion. It is unknown outside of America. The Commission on the Reorganization of Secondary Education has made a rather thorough investigation of secondary education in this country and in Europe. It reaches this conclusion: "The eight years heretofore given to elementary education have not as a rule, been effectively utilized.—We believe that much of the difficulty will be removed by a new type of secondary education beginning about 12 or 13." C. H. Judd, *Ibid.*, July, 1914, says, "....Every indication would seem to point to the conclusion that even seven years are more than adequate for elementary training in the proper sense of the term." He has since dropped the 7th grade from his practice school. Wm. F. Russell, J. J. Tigert, I. I. Cammack and the Editor of *School Life* are quoted with respect to a reduction of primary-secondary education. The *Quarterly* is not opposed to the Junior High School idea, but strongly advocates that the high school begin "about 12 or 13" believing that in the reorganization, in many cases, a year can be saved by organization on the 11 year basis. J. HOWARD GRAHAM

Teaching—A New Science. E. BERG. *Oregon Teach. Mo.*, **29**, 21 (Dec., 1924).—In the opinion of Prof. J. F. Bursch "teaching will be a true science when schools of all degrees become life itself—not merely a preparation for life." Scientific measurements of individual differences and abilities must first become effective. Their use in education is increasing at the rate of 500% per year. Within 5 years every institution in the U. S. will use some system of scientific testing. All school work should be motivated by a life motive. All knowledge which is worth while must meet some definite need in society. Practical tests which are time savers for both teacher and student and which can be applied to all subjects from the grades through college may be classified under 4 heads: (1) True and false statements. (2) Completion test. (3) Multiple choice. (4) Determination of general law to fit the specific application. B.

Complexities of the Industrial Chemist. (Perkin Medal Address.) HUGH KELSEA MOORE. *Oil Paint & Drug Reporter*, **107**, 4, 20 (Jan. 26, 1925).—"The Industrial Chemists' controlling motive is to translate potential benefits into actual benefits." In many chemical industries engineers and not chemists are occupying the manager's chair. "What is the reason? May I say that the engineer is human while the chemist is not?....The chemist works with inanimate matter: the engineer with both animate and inanimate. It thus happens that the chemist does not understand his fellowmen. While carrying out his projects, he has to come in contact with his fellowman, and in so doing receives jolt after jolt until he acquires the needed knowledge...." "I wish especially to warn the young chemist of the dangers attendant to the building of a mausoleum and enclosing himself therein. I have known many teachers to become insufferable egotists because of their exclusive daily contacts with minds in less developed stages than their own. They become highly incensed and intolerant when they find matured minds do not take them at their own valuation.....The hermit chemist is born to the people, but he forsakes his kind for an artificial atmosphere of evil smells. He so loses his sense of the fitness of things as to be unable to return to his original environment." In addition to being able to associate with people in a business way, the chemist should have an understanding of patents, a knowledge of business, labor, costs, machinery, fire hazards, effect of process on public opinion, probability of discovery of superior processes, advertising, etc. The article concludes with a description of the old type diaphragm cell. D. C. LICHTENWALNER

Wires Made Flameproof by Selenium Treatment. *Science Service.*—Fireproof insulation for telephone switchboard wires is made possible by a new use recently discovered here of selenium, an element whose chief use hitherto has been in apparatus involving the control of electric current by light. The flameproofing of switchboard wires is highly important, for even a small fire can undo many hours of work and throw a whole exchange out of commission. Fireproofing substances now in use are only partially successful. The peculiar thing about the use of selenium for this purpose is that the element itself can be burned. Only when it is used on the cotton covering of the

wires does it take on fireproof qualities. But then the wire resists all ordinary flames, and even when ignited by the intense heat of a blowtorch goes out immediately when the outside flame is removed.

Liquid Air Plant at the University of Kansas. H. P. CADY. *Grad. Mag. U. of Kansas*, **23**, 15–7 (Dec., 1924).—The original liquid air plant, installed in 1903, was the second in the country in an educational institution and for many years was the only one in the middle west. With it, important investigations were carried out which were largely responsible for the present helium industry in the U. S. It was also possible to show that "natural gas contains not only helium but also argon, neon, krypton, xenon and radon, in fact, the whole family of inert gases. A new plant has just been installed, in which a compressor runs the air pressure to more than 3000 lbs. per sq. in. A purifying train removes carbon dioxide and water. The air is precooled by an ammonia refrigeration system before going to the liquefier proper. The capacity is 5 liters of liquid per hr.—several times the rated capacity of the machine. B.

Exhaust Gases from Engines Using Ethyl Gasoline. R. R. SAYERS AND A. C. FIELDNER. *J. Frank. Inst.*, **199**, 271–4 (Feb., 1925).—Problem of elimination of "knock" from operation of the engine. Ethyl gasoline, one of the widely used anti-knock fuels is ordinary motor gasoline to which has been added 3 cc. of tetra-ethyl lead and 2 cc. of a halogen carrier, as ethylene dibromide or trichloroethylene, or approximately 0.04 per cent of the lead compound and 0.06 per cent of ethylene dibromide by volume. Ethyl gasoline should not be confused with ethyl fluid, which is a mixture of concentrated tetra-ethyl lead and ethylene dibromide in proper proportions for mixing with gasoline, but is not a motor fuel and is not sold to the public. The only danger of lead poisoning to the public from products of the combustion of ethyl gasoline seems to be confined to the mechanic. There was no indication of plumbism in any of the animals used in tests, though they were exposed for 188 days during a period of approximately eight months to exhaust gases from ethyl gasoline. See also Serial 2655, Bureau of Mines. J. HOWARD GRAHAM

Metallurgy. (**"New Light on the Bible, Revealed by Excavations at Ur."**) *World's Work*, **49**, 177–91 (Dec., 1924).—A report of the joint expedition of the Brit. Museum and the Univ. of Penna. Museum, consisting of photographs with descriptions furnished by the Univ. Museum. A gold scaraboid, with inscription, is probably one of the oldest, if not the oldest dated object of metal (about 4500 B.C.). Other metal objects found consist of copper, whose use antedates bronze.

Artificial Gasoline. EDWIN E. SLOSSON. *Science Service.*—"One of the most pressing problems of the present time is: What are we going to do when the oil runs out? .. Already the question has become acute in countries less oily than ours. In England, Germany and France, chemists are hard at work trying to invent ways of making something to match the natural petroleum that is still being so recklessly wasted by us. . . . . The British Department of Scientific and Industrial Research is experimenting on low temperature carbonization and has worked out a process that gives a gaseous fuel for local use, a liquid fuel suitable for motors, and a solid smokeless fuel, which they call "coalite," for household and industrial purposes. In Germany the Bergius process of treating powdered coal with hydrogen under high temperature and pressure is said to be capable of converting low-grade lignite into a synthetic petroleum equal to the natural. In France, a Rumanian chemist, Georges Olivier, in collaboration with a French mining engineer, Charles Andry-Bourgeois, has invented a process claimed to be capable of converting coal, wood or any kind of carbonaceous material into gasoline of higher heating value than that obtained from petroleum. This is accomplished by the aid of certain catalysts which have the power of effecting the desired combination of carbon with hydrogen at high temperatures. Exactly what these catalysts consist of is not revealed in the account of the process given in the October issue of *La Science et La Vie* but they are stated to be made of certain metallic powders spread upon infusorial earth, pumice, clay, charcoal and other porous bases. The first stage of the process is similar to the familiar method of making coke and illuminating gas. The coal or lignite is mixed with from five to twenty-five per cent of lime, soda or alumina and heated in tight retorts. The distillate of tar, ammonia and light oils is condensed and utilized. The coke remaining in the retort is converted into water-gas by the well-known method of passing steam over it while red hot. Water-gas is a mixture of hydrogen and carbon monoxide, both excellent combustibles and both employed in later parts of the process. The gaseous output of the coke oven consists of free hydrogen, methane and more complex compounds of hydrogen and carbon. It is essential for the next step that there should be an excess of hydrogen. If the mixed gas contains less than fifteen or twenty per cent of hydrogen by weight more must be added. This additional hydrogen may be obtained

from the water-gas or, if necessary, by decomposing water by electric current. The second stage of the process consists in passing these gases through an electrical furnace heated to 3000 degrees centigrade. This transforms the methane into acetylene and changes the other hydrocarbons into forms more active and ready for combustion. The gaseous mixture so obtained is next conducted under pressure through tubes containing the catalyzing agents. The temperature at the beginning of this, the third, stage of the process is about 150 degrees centigrade at first, but rises to 400 degrees at the end. Contact of the gases with these finely divided metals somehow causes the smaller molecules to hook up together and form larger molecules, and the colorless gas that entered the tube comes out as a colored oil, which, like the distillate of natural petroleum, looks red by transmitted light and green by reflected light. It contains about 75 per cent of very light gasoline. In the fourth and final stage this colored oil is again passed over metallic catalyzers with an excess of hydrogen at a temperature of 180 degrees. The finished product is a light limpid colorless liquid having a very agreeable odor. It consists largely of what the chemist calls the "hydrogenated compounds of the benzene series," such as cyclohexane. In composition it consists of about 86 per cent of carbon, 13.5 per cent of hydrogen, with very little oxygen and less sulfur. The process seems pretty complicated but according to figures of M. Olivier gasoline can be manufactured from the French lignites at a cost of twelve cents a gallon, which is less than a third the present price of gasoline in France. The initial plant constructed at Asnieres is expected to turn out a thousand tons a day. Twenty-five per cent of the carbon in the original coal comes out in the form of gasoline. The rest is mostly employed in heating the gas and apparatus and running the engines."

Chemical Education. (Editorial.) H. R. SMITH. *Chem. Bulletin*, **12**, 42 (1925).—The alchemists were secretive with what they knew. The phlogistonists were a bit overtalkative. The modern chemist, since he has learned to so successfully "check up the vagaries of the human mind" by experiment, should give more of his discoveries to the public. In telling the story of his achievements to the public the chemist will not only increase the general enlightenment but will also add to the public's appreciation of him and what he has done. In doing this he must speak in a language that is understood both by the younger and the passing generation. This task is primarily the opportunity of the teacher. The local and the national Chemical Education sections are in existence partly for encouraging and helping to qualify teachers for this undertaking.

B. CLIFFORD HENDRICKS

The Elimination of Waste in Education. O. W. CALDWELL. *Chicago Sch. J.*, **7**, 177–81 (Jan., 1925).—To establish the essentials of any subject the following demands will have to be complied with: (1) social demands, (2) economic demands, (*a*) in the subject itself, (*b*) in the methods of presentation, (3) demands on the subjects preparatory to the one under discussion, (4) demands on those subjects for which this one is preparatory, and (5) demands based upon the ability of the individual. Scientific determination of essentials is a very exacting work, as evidenced by the recent reconstruction of algebra, by Rugg and Clark. The elimination of waste in education is one of the most important problems confronting us. B.

Sponge Iron to Simplify Extraction of Metals. *Science Service.*—"The production of sponge iron, a finely separated form of the metal, and very useful in chemical and metallurgical industry, has been made possible on a large scale by researches conducted at Seattle by the Bureau of Mines of the U. S. Department of the Interior. The process depends on the fact that most iron ores are oxides of iron, and that if the oxygen can be extracted at temperatures so low that the iron does not fuse or run, it is left standing as a very fine, porous metallic sponge, presenting very large areas of free surface, on which the reactions of chemical manufacturing processes can take place. The process also promises to render possible the profitable production of iron from low-grade ores and furnace wastes. During the past year a furnace using the new process was operated commercially at Silver City, Utah, producing about three tons of sponge iron daily."

University of London's New M.Sc. Degree. I. B. HART. *J. Educ. Sch. World*, **56**, 602–6 (1924).—The University of London is an examining as well as a teaching organization, and is now prepared to offer post-graduate science for non-specialists. A way is opened for teachers of science and mathematics in secondary schools to keep themselves fresh and mentally vigorous. Unless recent university graduates who take up teaching have opportunity to do some advanced work, they are apt to become unambitious and resigned to orthodox routine. London offers courses in "The Study of the History and Method of Science." It is now pretty generally recognized that science means more than the mere cash value of its utilitarian inventions and the capacity to produce "death" and other rays. Scientific education has cultural aspects. Indeed, the prog-

ress of scientific thought is closely related to the progress of civilization itself. The following is an outline of the syllabus: (*a*) General history of science; (*b*) history of physical and mathematical sciences; (*c*) history of biological sciences; (*d*) method and principles of science. (*a*) is compulsory for all, and either (*b*) or (*c*) must be taken. Part of (*d*) is required. The lectures covering the syllabus will be delivered at University and King's Colleges. The course will take a *full* year. Part-time students must devote two years to the work. The course is open to external as well as internal students. A science degree from a recognized institution is required. It is to be hoped that no one who is attracted to the idea of the new degree will be deterred from working for it because he or she cannot have the lectures. "It is the reading which matters and which tells in the examination room." For particulars, write to Dr. Charles Singer, University College, London. WILLIAM FOSTER

Achievements of Pupils in Chemistry. S. G. RICH. *Sch. Sci. Math.*, **25,** 145–9 (Feb., 1925).—More chemistry tests have been made for chemistry than any other science. The findings of all tests show a great range of attainment within the school and the class. The rate of progress of a group of pupils is less than one-fifth of the range of attainment of the group. The Bell-Texas, Cleveland Coöperative, and Rich tests are compared and discussed according to nature and content. In a comparison of attainment as shown by Rich's tests an advance from 43.5 to 53.2 was made by high school pupils between the end of the quarter and the full year. In the same interval college students advanced from 46.2 to 52.3 and high school pupils who continued the study of chemistry in college advanced from 55.1 to 57.4 for approximately 100 cases. It is proposed that colleges and universities grant entrance credit in chemistry on the basis of two of these tests in which the pupil makes a score above the mean of the test.
H. R. SMITH

Status of Science Education in China. GEORGE R. TWISS. *Sch. Life*, **10,** 53 (Nov., 1924).—In native ability and in interest in their students the Chinese teachers compare favorably with teachers of other countries, but they are deficient in a knowledge of the fundamental principles of teaching sciences. The few who do have skill in demonstrating, experimenting and scientific thinking are those who have taken courses of training in the laboratories of high-grade colleges and universities in Europe and America or under highly trained foreign teachers in China. With very few exceptions the science teaching in the middle schools consists almost exclusively of formal and bookish lectures. In most cases lectures are illustrated with blackboard diagrams. Experiments and demonstrations are used, but as they are not skillfully performed and not seen in detail by all the students they are not convincing evidence for reaching logical conclusions. Occasionally one finds a really brilliant lecturer who draws with amazing skill and rapidity while he talks. Still less frequently one finds a lecturer who makes full and efficient use of the apparatus, charts and specimens. In only three of the middle schools is all the science work on a good laboratory basis. Recitations are infrequent. Classroom discussions, blackboard demonstrations by students, reports from reference readings and topical recitations are very rarely required. Most questions are answered by from one to five words. Occasionally one hears a thought question, but it is generally directed indefinitely to the whole class. The different answers come in a confusing volley from various parts of the room. B.

The Vocabularies of High School Science Textbooks. S. R. POWERS. *Teach. Coll. Rec.*, **26,** 368–82 (Jan., 1925).—A study of certain textbooks in General Science, Biology and Chemistry, in an effort to determine the number of unfamiliar words in each text. As a basis for such determination Thorndike's "The Teacher's Word Book" is used. Apparently ninth grade children recognize about two-thirds of the 10,000 words in the Thorndike list. The article throws some light on the extent to which the content of the text is suited to the needs of the student for whom they were prepared, and is in a way a measure of the relative difficulty of textbooks. The author finds that biology texts have a larger number of unfamiliar words than the chemistry texts examined, while the general science textbooks designed for ninth grade work have fewer unfamiliar words. Since chemistry is usually given in the third or fourth year high school classes, this fact was to have been expected in the case of chemistry, but it seems to show that the vocabulary burden in biology is unduly great. The author admits that these implications are controversial and that one important function of a text is to increase the reader's vocabulary. He does find, however, that a large proportion of the unfamiliar words are technical and rather difficult, and that a large number, usually more than 50%, of the unfamiliar words in such texts are used only once. If the purpose of science instruction is partially to increase the vocabulary, the instructor will be forced to supplement the text in cases where the frequency of words is so low. There seems to be no

convincing evidence that the writers of science textbooks are more serious offenders in this respect than those in history and other subjects. CHAS. E. DULL

Citizenship Lectures as a Part of College Education. ANON. *J. Am. Pharm. Assoc.*, **14**, 23 (1925).—The School of Pharmacy of The Medical College of Virginia has arranged a course of lectures on the general subject of Citizenship, to be given to all of their students by eminent citizens and statesmen. Some of the most prominent citizens of Virginia have consented to participate in this enterprise, and it is hoped that this move will materially aid in enabling the young professional man to realize very definitely his fundamental obligations to the community as a good citizen. J. C. KRANTZ, JR.

Character Tests for Pharmacy Entrants. F. J. WULLING. *J. Am. Pharm. Assoc.*, **14**, 52 (1925).—The great civic and moral obligations incumbent upon the practise of pharmacy today demand men of the highest caliber for this profession. The logical place to select the best who come to the profession is at the matriculation in the University. The writer suggests that all applicants for matriculation in pharmacy schools be required to pledge themselves to the high code of ethics established by the American Pharmaceutical Association. By instilling the proper moral conceptions into the student early in his career, the basis for the production of a better man is thereby established. Sufficient activity of this kind will likely be the beginning of an ethical and moral renaissance within the profession. JOHN C. KRANTZ, JR.

Notes on Alloy Metals Used in Alloy Steels. JULIUS L. F. VOGEL. *J. Soc. Chem. Ind.*, **43**, 365–9 (1924).—This paper contains excellent information for teaching alloy steels which are under chemical and physical investigations in many laboratories and factories. With the physical structure of alloy steel as a background, tables of useful and deleterious elements in alloy steels are given with brief discussions of the effects of their presence on the structure and properties of the alloy. The sources and metallurgy (briefly) of these alloy elements are given. LOUIS W. MATTERN

Relation between Industry and Chemical Warfare. C. H. BEEBE. *Chem. Warfare*, **2**, 2–11 (Jan., 1925).—"Success in war demands success in industry and preparedness requires the existence of well-organized thriving factories." Sulfuric and nitric acids and dyes are of fundamental importance. Because of its great complexity the dye industry fosters most other chemical industries. It is peculiarly related to the manufacture of pharmaceuticals and explosives as well as war gases. An accompanying chart, with descriptive paragraphs taken from Chemical Warfare Service Information Set No. 57, shows how some 56 important chemicals can be easily diverted to either war or peace-time uses. "It is evident that those who have a thorough knowledge of these reactions and can successfully carry them out on a commercial scale can, in peace time, produce commercial chemical products and, in war time, gases and explosives." For national security "it is essential that each country should have its chemical industry firmly established." B.

The Need and Use of a Scientific Measure of the Results of the Teaching of Chemistry. H. L. GERRY. *Sch. Sci. Math.*, **25**, 157–68 (Feb., 1925).—To make education scientific it is necessary to measure achievement accurately. The common ratings of pupils according to the excellence of work have meaning only when the standards of the school and the characteristics of the teacher are also known. Marks on the percentile scale are not comparable unless the passing grade is uniform. The teacher's judgment of pupil effort may not be consistent for there are no standards used in the estimate of pupil effort, the various attainments in recitation laboratory, and examination. Investigators have found wide ranges of marks in the grading of the same papers by different teachers in English, mathematics and history. An examination paper in chemistry was scored by ten teachers with a range of from 55–80% in the marks given. An achievement of the same value is rated differently if performed by pupils in different years of the school. The distribution of marks for any given class does not always follow the regular form of a Gaussian curve which is expected (if the conditions of the instruction are normal). Inexperienced and untrained teachers frequently prepare questions for examinations without the care to have them equally weighted. For the above reasons standards of measuring achievements of pupils are desired and better still, methods of instruction should be tested to know whether they are certain to give the desired results. H. R. SMITH

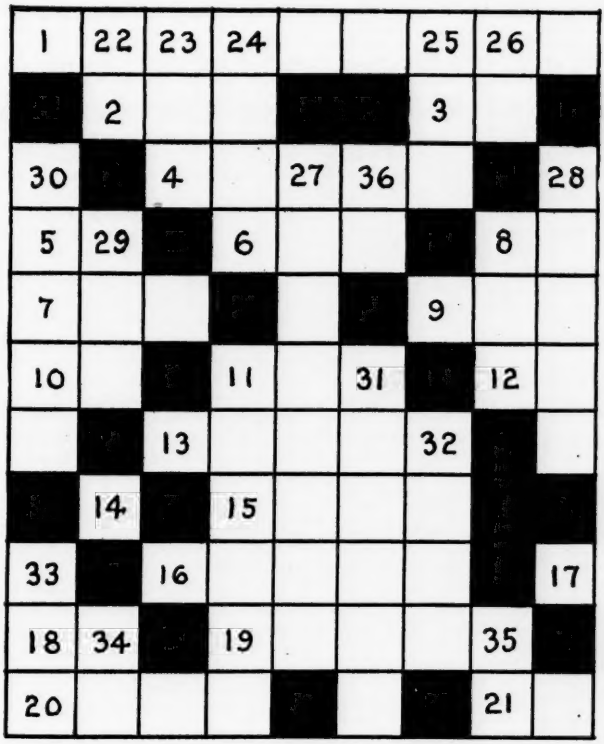
Artificial Gold. EDWIN E. SLOSSON. *Science Service*, Feb. 9, 1925.—"For some three thousand years, off and on, chemists have been trying to make gold out of the baser metals. Just now they are on the quest again with as high hopes as the medieval alchemists and with better reason. We now know that some atoms can be broken to pieces and that some elements can be transmuted into others. The metal radium decomposes spontaneously into the gas helium and the metal lead. Professor Rutherford

has split up the nitrogen atom into helium and hydrogen. The helium atom weighs 4 and the hydrogen atom weighs 1. The helium is supposed to be made by the combination of 4 hydrogen atoms. Now if you subtract the weight of the gold atom (197) from the weight of the mercury atom (201) you get 4. So it would seem that if you could knock out from the mercury atom a helium atom, or its equivalent 4 hydrogen atoms, you would get gold. But can you? That is the question. This may be, like many another chemical reaction, easy to write out on paper yet impossible to accomplish in the laboratory. But two chemists, a German and a Japanese, say that they have done it. Prof. A. Miethe of the Photochemical Department of the Berlin Technical High School, who has been for years studying the discoloration of minerals and glass by ultra-violet light, found that the mercury vapor lamps used as a source for these rays ceased after a time to work owing to the deposit of a sort of soot on the quartz glass wall. He tested this deposit and got indications of gold. Now it is not surprising to find a trace of gold in commercial samples of mercury, for mercury is one of the few liquids that will dissolve gold and is used to extract the precious metal from sand or ores. But the mercury in the lamps had been twice distilled to free it from all impurities and on analysis showed no trace of gold until after it had been subjected to the prolonged action of the electric current in the lamp. The quartz, the iron and the carbons of the lamp were also analyzed and pronounced gold-free. Miethe sent samples of these and of the mercury, before and after using in the lamp, to Professor Haber, the inventor of the Haber process for fixing nitrogen, who has been interested in the extraction of gold from sea water and had developed a very delicate method of estimating gold in minute amount. He reported finding gold and in some cases silver in the samples that came from the lamps. The amount varied from one to fifty-two parts in a billion parts of mercury. From these experiments, which Miethe has carried on with his assistant, Dr. H. Stammreich, since last April, he concludes that some of the atoms of the mercury have been crumbled away by the electric current passing through the vapor, leaving gold as a residue. In his lamps he used 170 volts between the electrodes and ran currents from 400 to 2000 watts for periods of 20 to 200 hours. From the other side of the world comes the report of similar success in the manufacture of gold artificially. Professor Hantaro Nagaoka of the Tokyo Imperial University has published a photograph of a deposit of gold which he obtained by running a mercury lamp for more than 200 hours under a voltage of 226. The gold obtained amounted to a milligram and a white metal that appears to be platinum was also produced. In the United States Prof. H. H. Sheldon of New York University is engaged in repeating these experiments and doubtless many others are quietly carrying on the quest. But there is as yet no apparent reason for the alarm that synthetic gold will upset the standard of the world's currency. The process, if possible, is too expensive to be profitable. Although gold is more than three hundred times as costly as mercury yet the electric current would cost more than the value of the gold produced. This is likely to remain true however much the efficiency of the apparatus is improved. Professor Miethe expressly warns the public that his discovery of the possibility of decomposing the mercury atom has no commercial importance and that speculation in this direction is rash and premature. There is no ground for the suspicion that the Germans are secretly manufacturing gold with intent to pay off all their war debts before the rest of the world learns how. If the aim is to produce wealth, it would be much more profitable to find out how to get energy out of the atom than how to transform the elements by putting energy into the atom."

The Meaning of Scientific Research. M. I. PUPIN. *Science*, **61**, 26–30 (1925).—"That which characterizes true scientific research is the mental attitude of mind." The nature of this attitude is richly illustrated by references to the pioneer scientific work of John Henry, John William Draper, Robert Mayer, Hermon Helmholtz and Carnot wherein eternal truth was their dominant objective rather than practical applications. The rare genius will succeed in spite of training, therefore it is to the development in terms of the mental attitude of scientific research of the many millions who are not geniuses that the special appeal is made. This attitude is to be created by learning the universal language of nature, which is the most accurate of all languages and whose sentences are absolutely logical, through a direct study of nature and its operations. He agrees with President Barnard, Joseph Henry, William Draper and President White that this language of nature must begin early with a study of things. P. quotes from Tyndall's lectures in this country to the effect that teachers of science would be more effective in developing in their students this mental attitude of mind in scientific research if, in addition to teaching they would "try to add a rill to the great stream of scientific discovery." Tyndall is further quoted as stressing the importance of this attitude of mind not only in understanding the truth of nature in order to apply it more

successfully to human welfare, but also as being essential to the solution of great political problems. In the language of President White, "I will confine myself to the value in our progress of the spirit and example of some of our scientific workers of our day and generation. What is the example of that spirit? It is an example of zeal, zeal in the search of truth, of thoroughness, of the truth sought in wholeness, of devotion to duty without which no scientific work can be accomplished, of faith that truth and goodness are inseperable." Henry Rowland is quoted, "Thus is the mind destined to govern the world. This is the kind of mental attitude we need not only in the solution of all human problems, not only the problems of science." Attention is called to the desire of the industries to have men trained in the mental attitude of true scientific research, for their most important work is pure scientific research. LOUIS W. MATTERN

Technical Developments of the C. W. S. since the War. F. B. GORIN. *Bull. U. S. Chem. Warfare Assoc.*, **2**, 4–6 (Feb., 1925).—"The researches of the Chemical Warfare Service since the war have resulted in a great many important discoveries which are of value not only in warfare, but also in various peace-time activities. The *most important development has been the new Army gas mask*, which is the most highly efficient gas mask in the world. This mask eliminates most of the discomforts of the former mask, such as those due to the nose clip and mouth piece. Several types of this mask have been developed for special purposes for the use of both the Army and Navy. A *new one-position side carrier for the mask* has been developed and adopted. Also, an entirely *new canister* has been developed, such that it will protect against any war gas used. *Special canisters* have also been developed for protection against particular gases, such as carbon monoxide, ammonia and hydrocyanic acid. An "All-Purpose" canister is filled with absorbents suitable for affording protection against practically all gases and fumes encountered in the industries. The late war demonstrated the high tactical value of smoke as a protecting screen for the various arms. During the past two years, the Chemical Warfare Service has brought the development of smokes and means for producing them to a high state of efficiency. The most outstanding development along this line has been that of *airplane screens and curtains* which give promise of providing a means of aerial attack and defense heretofore unattainable. This method of spraying chemicals from airplanes can be adapted to the distribution of insecticides over fields of grain and orchards. In coöperation with the Public Health Service, a *method for the fumigation of ships* was developed, which eliminates the danger formerly experienced with hydrocyanic acid then in use. This method involves the use of the tear gas, cyanogen chloride, which provides the necessary warning by causing a copious flow of tears. The *cotton boll weevil* destroys a large percentage of the cotton crop each year in spite of the use of calcium arsenate, which, however, under ideal conditions, is fairly effective in minimizing the loss. Last year, $25,000 of the appropriation for the Chemical Warfare Service was made available for the purpose of attacking this problem. The work thus far has been largely confined to the laboratory testing in Georgia and South Carolina of a great number of toxics against the weevil. It will be necessary to carry out field tests with the more promising toxics before definite conclusions can be drawn. In coöperation with the National Research Council, and with other Government Bureaus, the Chemical Warfare Service has been seeking some means for *protecting marine piling* from the attack of marine borers. A number of quite satisfactory toxic materials have been found, and the results of the work of the Chemical Warfare Service are included in the report of the National Research Council recently published. Similarly, in coöperation with the Navy Department, experiments have been made for the purpose of developing an *anti-fouling paint for ship bottoms*. A number of such paints have been manufactured and have been given certain tests which indicate that a satisfactory solution of the problem will be found. Details of these operations will be given from time to time in the Association's publications. Among the various researches carried on by the Chemical Warfare Service, the experimentation undertaken to determine the curative value of various toxics has resulted in exceptionally important possibilities. Among the developments to date which have given positive results, is the use of *chlorine as a therapeutic agent* in respiratory diseases, both for human beings and for animals. One of the very greatest uses of warfare gases that is just beginning to be understood, is the use of *tear gases* (Chloracetophenone, etc.) for preventing robberies of banks, for driving desperadoes out of barricaded buildings, and for controlling unruly mobs. So effective have some of the tear gases already proven in protecting banks and messengers carrying money bags, that certain insurance companies have agreed to reduce insurance rates for banks equipped with tear gas apparatus. B.



ACROSS

1. Result of a gain of electrons.
2. What a football player tries to do when he gets the ball.
3. Symbol for osmium.
4. Heaviest of the inert gases.
5. Symbol for the last member of the alkali family.
6. Element of the fourth group chemically similar to lead.
7. Suffix indicating salt of -ous acid.
8. Symbol of the metal found in marble.
9. Suffix indicating lower valence.
10. Symbol of only element beginning with D.
11. Compound formed by interaction of higher organic acids with glycerine.
12. Symbol of element similar to sulfur but of heavier atomic weight.
13. Beverages made from grapes.
14. Symbol of Iodine.
15. Complete the sentence "Our prof. has a great - - - -."
16. French noun meaning study.
17. Symbol of nitrogen.
18. First part of prefix meaning without water.
19. Impure natural form of aluminum oxide.
20. Very common direction in laboratory manuals.
21. Symbol for the former name of glucinum.

DOWN

8. Student's term for absence from class.
11. Operation employed to separate solid from solution.
22. Interpolation frequently used by a poor lecturer.
23. Occupation of bill collectors.
24. Certain definite quantity used as a standard of measurement.
25. Electrically charged solute particle.
26. Same as 3.
27. Element of group four resembling silicon.
28. Substances yielding OH ion.
29. Farm enclosure descriptive of laboratory after a freshman class.
30. Substances yielding H ion.
31. Kind of heart you hope your prof. has.
32. Old word applied to reader of the future.
33. State of matter into which a substance passes at boiling point.
34. Symbol of an inert gas.
35. Symbol of a rare earth.
36. Opposite of off.

Local Activities and Opportunities

New England Association of Chemistry Teachers. A very well attended meeting of the New England Association of Chemistry Teachers was held at the Boston English High School on Saturday, Feb. 14, 1925. President Leslie O. Johnson called the meeting to order at 10:00 A.M. and introduced Mr. Fred. R. Miller, Head of the Science Department of the Boston English High School, who welcomed the association to the first established physical and chemical laboratories in the secondary schools of this country. Mr. Charles H. Stone of the Boston English High School gave a very instructive and entertaining talk on "Some Experiments with Nitrates" which he illustrated with many well chosen demonstrations. Professor A. L. Pouleur of Wheaton College showed "Models Used in Teaching Organic Chemistry" and built up some more complex formulae from atoms and simpler molecules represented by balls of various colors and different types of attachments. Mr. Walter F. Downey announced courses for teachers in the Teaching of General Science, Biology, Physics, Chemistry and Mathematics with round table discussions to be given at the Summer School of the Massachusetts Institute of Technology where splendid facilities are available. Professor L. A. Olney of the Lowell Textile School gave a very interesting talk on "Some Applications of Chemistry to the Textile Industry" in which he told of natural and artificial textiles, the dyeing and finishing of these. He mentioned that artificial silk may soon replace the natural because it wears longer and better. He is unable to supply enough good young men for positions which generally pay at least $5000.00 within four years out of the textile school.

President Johnson announced the following meetings for 1925: March 14 at Brown University; May 2 at the New Hampshire State University; May 16 at the Mt. Hermon School; Nov. 14 at Wheaton College; and Dec. 5 at Bridgeport, Conn., to be a joint meeting with the Chemistry Teachers' Association of New York. Division Chairman Ricker of the Woburn High School took charge of a chemical cross word puzzle, awarded prizes and presided over the business meeting where new books and matter of interest to teachers of chemistry were discussed. "The Fountain of Youth" and two sport reels were shown in motion picture by courtesy of the Chelmsford Co. after which the laboratories were inspected.

University of Michigan. Helen Updegraff who has held a research assistantship in physiological chemistry at the University of Michigan is taking a year of rest at present. She is located at Prescott, Arizona.

University of Wisconsin. Vandeveer Voorhees has completed his work for his Ph.D. at the University of Wisconsin, and taken a position as research chemist with the Standard Oil Co., of Whiting, Ind.

National Committee on Chemical Laboratories. The National Research Council has appointed a committee on the Construction and Equipment of Chemical Laboratories. The personnel of this committee is:

George I. Coyle, S. J., *Chairman*, Georgetown University, Washington, D. C.

C. E. Hover, Wesleyan University, Middletown, Conn.

Louis W. Mattern, McKinley Technical High School, Washington, D. C.

J. H. Mathews, Wisconsin University, Madison, Wisconsin.

John G. Swan, University of Mississippi, University, Miss.

The committee will gladly receive builders' plans, specifications, blue prints of laboratories both high and college, recently erected or in course of erection, new ideas with regard to systems of ventilation and of drainage, types of laboratory furniture, and new efficient laboratory apparatus.

Mr. Garvan lectures in Boston. Speaking on the subject, "From Alchemy to Creative Chemistry" before the Boston Chamber of Commerce, Mr. Francis P. Garvan declared the hope of future medical advance to be largely dependent upon chemistry. He quoted Dr. Mayo as stating that the doctor has gone as far as he can go, that the surgeon has reached the limit of his effectiveness, and that only by the physicist and the pathologist and the chemist working with the doctor was there hope of further advancement. "The combination of a hospital with a chemical laboratory is the dream of the medical leaders," said Mr. Garvan. "We want a few millions to spend on chemistry of medicine. We want to go after the chemistry of the human body as we have gone after the chemistry of a lump of coal."

—*Business Chemistry*, Vol. **2**, No. **6**, p. 72.

Chandler Medal. The Chandler Medal for distinguished achievement in science was on February 13 bestowed upon Dr. Edward Calvin Kendall, head of the Chemical Section of the Mayo Foundation for Medical Education and Research, University of Minnesota, at Havemeyer Hall, Columbia University, in the presence of leading chemists and educators from uni-

versities and laboratories in the East and Middle West.

Dr. Kendall, as Chandler Lecturer for 1925, delivered an address on "The Influence of the Thyroid Gland on Oxidation in the Animal Organism." The medal and lecture are provided annually by the Chandler Foundation, established in 1910 by friends of Dr. Charles Frederick Chandler, Mitchill Professor Emeritus of Chemistry in Columbia and known as the dean of American chemists.

Dr. Kendall, a graduate of the Columbia Schools of Mines, Engineering and Chemistry in 1908, and a recipient of a Ph.D. degree from the University in 1910, is the first Columbia man as well as the youngest scientist to be honored by the foundation.

The medal was presented by Dr. Chandler, now in his ninetieth year.

Others who have received the Chandler medal include Dr. L. H. Baekeland of New York, past president of the American Chemical Society; Dr. W. F. Hillebrand, U. S. Bureau of Standards; Dr. W. R. Whitney, Schenectady, N. Y.; Dr. F. Gowland Hopkins, and Dr. Edgar F. Smith, Provost Emeritus of the University of Pennsylvania.

New Jersey Chemical Society. At the regular monthly meeting of the New Jersey Chemical Society held in Newark on February 9, quite a large majority voted in favor of a petition requesting that the society be affiliated with the American Chemical Society as the North Jersey Section. Prof. M. T. Bogert, of Columbia University, addressed the society on the subject of "Perfumes" and showed some exceedingly beautiful colored slides of flowers that find use in making perfumes. He also exhibited a number of specimens of synthetic perfumes.

Chicago Association. At the January Meeting of the Chicago Association of Chemistry Teachers, the ladies' program was directed by Miss Margery Stewart of New Trier Twp. High School, under the title "Some Objectives of a Conservative Chemistry Teacher." The matter of having a sufficiently limited number of fundamentals to teach so that there would be sufficient time for review and drills was accepted as good principle. The second point of teaching more knowledge and less information was considered wise even if less ground seemed to be covered. But it is a matter for every teacher to convince himself of by giving more time to directing pupils how to learn, and how to think. Training is worth more than information and just as many facts can really be better learned by giving more attention to method of learning and less to subject matter.

Credit Hours in General Chemistry. In one of the eastern institutions a survey was recently made of catalogue statements concerning the course in general chemistry in 63 representative colleges and universities in the U. S. While the information was not complete the data shown in the accompanying summary indicates the general practice.

In about one-fourth of the institutions two hours' laboratory are considered the equivalent of one hour recitation; in over two-thirds of them the ratio is 3:1.

A. The following table shows the length of time devoted to Chemistry 1.

	Number of institutions requiring		
	1 full year	2 trimesters	1 semester
1. For students without High School Chemistry	93.6%	4.8%	1.6%
2. For students with High School Chemistry	87.3%	9.5%	3.2%

B. The following table shows the total number of hours credit for the course in Chemistry 1 (calculated in semester hours):

	Number of institutions giving			
	10 or more	8 hrs.	6–7 hrs.	less than 6
1. To students without High School Chemistry	38.6%	38.6%	22.8%	0.0
2. To students with High School Chemistry	31.6%	36.9%	26.3%	5.2%

Science Teachers Dinner. Saturday evening, Feb. 14, about 435 persons sat down at the Cafe Savarin to a joint dinner of the Biology, Chemistry and Physics Clubs with other science teachers of New York City.

Dr. Edwin E. Slosson, the chief speaker of the evening, chose for his theme "Men of Genius." In an interesting manner Dr. Slosson cited many examples of men of genius whose contributions to scientific theory and knowledge were made while the men were in their 'teens or early twenties. From the length of such a list it did not seem that his quotation from Holmes that "Infant prodigies who get up early in the morning are apt to become quite conceited in the forenoon and very sleepy in the afternoon" applies to all cases. The speaker also raised the question as to whether "genius is 90% application, drudgery, or perspiration," or quite largely a remarkable natural ability. An interesting part of his paper included a study of the time and manner in which men of genius conceived their epoch-making ideas, and the stimuli which led to their development.

Chemistry Teachers of Northern New York. It seems evident that for the present no one plan for the organization of chemistry teachers will act equally well in all localities. Hence the success which attends different forms of organization

is the sincere effort of various local sections of the A. C. S. to be of service to teachers.

The Buffalo, Rochester, Syracuse, Ithaca and Eastern New York Sections held an intersectional meeting in Schenectady, February 6-7. The program on February 7 was devoted largely to the interests of chemistry teachers. Papers by Dr. R. A. Baker on "The Coöperation of Local Sections with Chemistry Teachers" and Prof. B. F. Bronson on "Activities of Eastern New York Section" stimulated discussions which resulted in the appointment of an intersectional Committee on Chemical Education, consisting of one member from each of the sections. This Committee, which has as its object "The promotion of a spirit of helpfulness and coöperation between the Local Sections for the A. C. S. and the teachers of Science residing in the territories of these Sections," consists of Dean Ed. Ellery of Union College, Chairman, H. A. Carpenter of Eastern High School, Rochester, J. H. Nair, of the Merill Soule Co., Syracuse, F. L. Koethin, of the Acheson Graphite Co., Niagara Falls, and Dr. C. W. Mason of Cornell University.

Since the State Teachers' Association has been divided into zones with different times of meeting the condition in N. Y. is such that the most logical organization of chemistry teachers seems to be around the local section.

Prof. Bronson described the plan evolved by the Eastern New York Section which was very favorably received. The following members of the Section have promised to contribute their services in the form of popular lectures to be given anywhere in their territory.

Prof. Barnard S. Bronson, State College for Teachers, Albany, N. Y., "Chemistry and Character."

Prof. A. W. Davison, Rensselaer Polytechnic Institute, Troy, N. Y., "Nitrogen or Helium or Petroleum."

Dean Edward Ellery, Union College, Schenectady, N. Y., "Energy and the Atom."

Prof. M. A. Hunter, Rensselaer Polytechnic Institute, Troy, N. Y., "Use of Electricity in Chemistry or Chemistry in Preparation of Metals."

Prof. R. A. Patterson, Rensselaer Polytechnic Institute, Troy, N. Y., "X-Rays or Radio Activity."

Prof. Peter I. Wold, Union College, Schenectady, N. Y., "Vacuum Tubes and Their Applications."

Prof. A. Knudson, Albany Medical College, Albany, N. Y., "Vitamins."

Dr. W. B. White, State Department of Agriculture, Albany, N. Y., "Food Poisons."

Lists describing the plan have already been sent to the high schools and it is hoped to put the plan in operation this spring.

The Chemistry Teachers' Club of New York City. The Chemistry Teachers' Club of New York has a membership of about 160 men from the colleges and high schools of the metropolitan district. The members of the Club are especially fortunate in having so many industrial plants close at hand.

The first trip of last year was a visit to the factory of the Nairn Linoleum Company at Kearny, N. J. There the men saw all the steps in the manufacture of battleship, printed and inlaid linoleum.

In December some of the members of the Club went to New Haven as guests of the New England Chemical Society. There they visited the Kolynos Dental factory, inspected the new laboratory of Yale University, and attended the discussion meetings of the New England Chemical Society.

At the plant of the Cooper-Hewitt Electric Company at Hoboken the men were shown the manufacture and assembling of mercury vapor lamps of both the D. C. and A. C. types.

The first dinner meeting of the year was followed by a thought-inspiring address by Dr. James Kendall on the subject "The Abuses of Water by Chemists." Dr. S. R. Powers then opened a discussion of the Chemistry Syllabus of Minimum Requirements and also furnished some interesting data pertaining to chemistry teaching. A general discussion followed.

On a Saturday morning in February the Club visited the factory of the United States Radium Corporation in Orange, N. J.

From the radium plant the men walked a couple of blocks to the Edison Storage Battery Works to see the complete fabrication of the Edison Storage Battery.

Another double-header took the men to Newark where they first visited the Pyrene Manufacturing Company's plant. After a trip through the factory which showed the assembling of the pyrene and other types of fire extinguishers, and the lacquering and Parkerizing processes, a demonstration was arranged to show the adaptability of the different types of extinguishers to different kinds of fires. This demonstration included extinguishers of the soda-acid, pyrene and foamene types.

Later at the factory of the United Color and Pigment Company those present saw the various steps involved in the making of lithopone.

One of the most interesting trips of the year was a visit to a factory at Clifton, N. J., where artificial silk is made by the cuprammonium process. Short cotton fibers are washed, bleached, and then dissolved in an ammoniacal solution of copper. When this viscous colloidal solution has been clarified and aged, it is forced out through spinnerets, which are made of gold and platinum. Each one contains 20 small holes 0.005 mm. in diameter. The spinnerets dip beneath the surface of a caustic soda solution which precipitates the viscous liquid as it issues from these small holes. As these small fibers come from the sodium hydroxide solution they are twisted together to form a single thread of

silk. The silk is then reeled in a dilute acid solution, treated with acetic or formic acid, washed and air-dried.

Following the annual dinner meeting in the Faculty Club rooms at the College of the City of New York, the club members had the privilege of hearing Dr. Edgar F. Smith give an excellent address on the "History of Chemistry in America." Dr. Smith was at his best as he pictured the struggles of the pioneers in chemistry. With that human touch of which he is master, he made his hearers more interested for the first time in their lives in the "men who do things" than in the "things that are done."

Recent Books

Inorganic Physical Chemistry. H. CARTLEDGE. Ginn & Company. Boston 1924. xv + 463 pp. $4.80.

The first impression one receives when starting to read this book is that it is more elementary than the usual text in Physical Chemistry. Careful analysis shows that this is not really so. The information is all there. It is simply being conveyed more painlessly than is usually the case. Strict attention to the business in hand and a scarcity of the "special cases" that make the average text rather awe-inspiring tend to produce this result. Professor Cartledge set out to write a TEACHABLE Physical Chemistry. He succeeded. Such a smooth-flowing, logical, interesting book, the critic has seldom read. Practical applications and theory are so intimately interwoven that even the dullest student should be lead to see "the use of it all."

Specific items that meet the critic's approval are an excellent introductory chapter on "Facts—Real and Apparent," an outline of the material covered at the beginning of each chapter, plenty of problems at the end of each chapter, frequent references to contemporary authors, and the emphasis placed on practical applications. Continuity is the keynote of this book as evidenced by the following outline: "The Nature of Matter," covering atomic and kinetic theories, gases, atomic structure, etc.; "The Nature of Solutions;" "The Nature of Reactions," where we find discussed chemical kinetics, equilibrium, energy changes, electromotive chemistry, etc.; "Applications." There is a most excellent discussion of atomic weights, of "valence" equilibrium (otherwise electromotive chemistry), and of the solubility product and its applications.

If adverse criticism can be made on this book, it is that all discussion of the periodic table has been omitted and that the chapter on "The Nature of the Atom," covering such subjects, as radioactivity, isotopes, atomic number, atomic disintegrations, etc., is too brief. Professor Cartledge purposely limited himself to a discussion of those phenomena that are most intimately connected with Inorganic Chemistry. For this reason he omits discussion of the physical properties of liquids and solids, of the vapor pressure of volatile mixtures, and of colloids. This somewhat limits the use of the book as a reference or as a text in colleges where a more extensive course in Physical Chemistry is taught. However this text is undoubtedly a move in the right direction in the teaching of Physical Chemistry and it is to be hoped that Professor Cartledge will shortly expand it so as to include the subjects mentioned. MALCOLM M. HARING

The Humanizing Knowledge. JAMES HARVEY ROBINSON. George H. Doran Co., New York. 1923. xi + 119 pp. $1.50.

"The American Chemical Society has asked the chemist to come forth from his laboratory and tell the story of his achievements to the public through the medium of the daily press, the magazine article, the popular article and the specially written volume."

The reviewer knows of no single volume that would as greatly aid the chemist in telling his story as the book under review. Doctor Robinson in the preface says, "When bills are ntroduced into state legislatures to forbid the teaching of 'Darwinism'....there is certainly need for renewing the age-long fight against traditional error." To aid in this he says, "I am setting down, in the following pages, certain fundamental conclusions which have emerged from many years of teaching and many hours of conference with those able and disposed to discuss the matter."

First the author calls attention to the general indifference of the public toward the scientist and his work. Then he places the fault for this neglect. The insistence of the scientist that he must be absolutely impartial has so dehumanized his findings that the lay public has neither found them nor the scientist attractive. Eventually, however, this dehumanized mass of knowledge has reached the public, mostly through its expression in material progress. Yet, while the common folk are ready to accept the principal of science, as applied to machines, or even

to the animal and plant world many will not follow when these same principles are applied to man and his relation to the natural world. They also refuse to substitute scientific methods for the haphazard ways of tradition. Here, then, the author claims, is the place where the "re-humanizing of knowledge" is most needed. His concrete suggestions on how to do it are then made.

It would not be amiss to say that all teachers are engaged in the task of "humanizing knowledge." Certainly any scientist must find in Doctor Robinson's brief volume much to stimulate his efforts to "come forth from his laboratory" and report his results to the public.

B. CLIFFORD HENDRICKS

A Diagnostic Study of the Subject Matter of High School Chemistry. S. R. POWERS, Ph.D. Teachers College, Columbia University, Contribution to Education, No. 149. Published by Teachers College, 1924. viii + 84 pp. $1.15 postpaid.

This pamphlet includes lists and tables, recording the results of 8 tests run in 1920–1922 in 15 Minnesota high schools and 28 high schools outside Minnesota.

This monograph was reviewed in the October number of THIS JOURNAL but the space available did not allow recording the conclusions reached by the author. These conclusions have been summarized from a careful study of the text itself and are as follows:

1. Most high school students "secure a clear comprehension of the application of valence" in building formulas.

2. They "acquire a pretty clear-cut notion of the meaning of the terms element, mixture and compound."

3. They are "less successful" in giving the chemical names of substances the common names of which are given them. Less than half of the students answered fifty per cent of these questions correctly.

4. Knowledge of definitions "is not acquired by many," *e. g.*, 35% of the students do not know that acids are characterized by the formation of hydrogen ions in solution, and about 55% cannot define efflorescence.

5. Upwards of 50% of the students classify correctly twelve selected members of the activity series.

6. Under biography "Priestly, Avogadro and Gay-Lussac are best known but approximately one-third of the students are unable to make proper associations for two of these men. More than half failed to associate the name of Dalton with the Atomic Theory. Arrhenius is almost an entire stranger."

7. Students' "knowledge of chemical changes and of laboratory and commercial preparation is woefully deficient," *e. g.*, "45% do not know the commercial source of ammonia." Data does not substantiate the claim often made that the "functional value of chemistry has been that it gives a knowledge of important industrial processes."

8. Naming the uses of chemical substances fares but little better, *e. g.*, "nearly 60% do not know that sulfuric acid is used extensively as a dehydrating agent."

9. Knowledge of the solubility of salts is rather meager.

10. "Ability to state numerical ratios between quantities of interacting substances and to make mathematical calculations" met with about 50–50% success. For detailed information about the problems see page 18 of the monograph.

11. "It is somewhat easier for students to write the names from the formulas than the reverse, yet only the simplest and most evident formulas are named correctly by more than 75% of the pupils. Only about half of these formulas are correctly named by 50% of the pupils."

12. "The formulas for some very common laboratory substances are written correctly by less than 50%. Difficulties in writing formulas seem to arise when it becomes necessary to insert a subscript."

13. Completing equations when the left-hand members are given is done correctly in about three-fifths of the cases.

14. Writing entire equations is done correctly in about one-third of the cases. "Comparatively few students are able to apply even the most elementary principles of oxidation and reduction in the writing of equations."

15. In all, 177 out of 303 items, or nearly 60% are answered correctly by less than 50% of the pupils.

16. The best answers are received from those schools where there are between 20 and 60 chemistry students.

17. "The task set for High School students of chemistry is beyond their accomplishment. Evidence is convincing that students obtain no mastery of a large amount of the materials of instruction."

18. "The items of the tests are not too difficult to be fairly representative of the materials contained in the commonly used textbooks," but they "are probably considerably easier than would be obtained from a random sampling of the textbook material."

19. "A large proportion of the textbook material means little or nothing to 50% or more of the students who have studied one of these texts in High School for one year."

20. "Knowledge and skill tested....are for most students almost completely lost within one or two years after instruction has ceased," although "ability to do items was retained much better in certain divisions of the test than in others."

21. "The ability of students who have studied chemistry in university classes to do the tasks in those tests is not appreciably different from that of students who have studied chemistry in the better high schools."

22. "Some of the difficulties which students encounter are no doubt due to the fact that they are plunged rather suddenly into the manipulation of materials which are for them entirely new."

23. "This study has been devoted to an examination of present practices and has revealed a situation which borders on the critical."

24. That textbooks should aim to give the student "the ability to think for himself" rather than to be "carefully prepared catalogs of the facts and principles of chemistry arranged under proper headings" is suggested as "an important function for work in chemistry."

The above conclusions were not summarized by the author of the monograph but were incorporated as parts of the running text. As many chemistry teachers may not see this particular monograph it seemed wise to the writer to compile these conclusions so that they might reach a larger reading public. They should be particularly applicable at present in connection with the study being given to the content and method for High School Chemistry as carried out by the Division of Chemical Education of the American Chemical Society.

WILHELM SEGERBLOM

Chemistry in Industry. H. E. HOWE (Editor). The Chemical Foundation, Inc., New York, N. Y. 1924. xii + 372 pp. 50 figs. 20 × 14 cm. Price $1.00 postpaid.

In the Foreword of this book there appears a clear statement of its purpose and scope. The editor says, "Notwithstanding the universal application of the data established by fundamental research, the Committee on Prize Essays of the American Chemical Society learned during the contest of 1923–1924 that the relation of chemistry to industry had not been set down in language easily understood, nor in places conveniently accessible to the thousands of students who desired to write upon that topic. Consequently, it was decided to provide at least one reference book that would be of assistance, and this book is the result. It is in reality a symposium to which twenty-one specialists in as many different industries have contributed chapters dealing with what chemistry has accomplished in their field of work and noting several unsolved problems to indicate a few of the many opportunities that await the resourceful, well-grounded chemist. It is hoped that the industries selected may be considered typical, and perhaps if this book achieves its purpose a companion volume may appear at a later date."

While designed for those who have little knowledge of theoretical chemistry, this volume will prove of no less interest and value to others, particularly to teachers of chemistry. Both the editor and the reader are to be congratulated upon its successful synthesis, and we hope that it will be but the first of an extensive "homologous series."

The first chapter, The Foundations of Chemical Industry, by R. E. Rose, includes an introduction to sulfuric acid, nitric acid, soda, soap, glass, caustic soda, electrolysis and chlorine. In a very interesting prelude the author likens electronic and atomic arrangements to a large number of balls handled by many jugglers who can move around and effect exchanges at will. "The chemist, without seeing them, has learned to handle these least units of materials in such a way as to get the arrangements which are more useful from those less useful.... All (industries) have this in common—they serve to rearrange atoms of molecules or to collect molecules of one kind for the service of man.... This is the wonder of the chemist's work: he finds that which is not upon the earth until he discovers it; just as the artist creates so does the chemist. If he did not there would be no chemical industry to write about."

The remaining chapter headings are fairly indicative of their content: II, Abrasives, by F. J. Tone; III, Alcohol and Some Other Solvents, by D. B. Keyes; IV, Coke, Coal and Their Products, F. W. Sperr, Jr.; V, Cotton and Cotton Products, T. C. Law; VI, Chemistry in the Electrical Industry, Buckner Speed; VII, Some Applications of Electrochemistry, A. H. Hooker; VIII, Chemistry in the Fertilizer Industry, R. B. Deemer; IX, Industrial Gases, C. S. Robinson; X, Glass: One of Man's Blessings, Alexander Silverman; XI, The Elements of Iron and Steel Manufacture, A. E. White; XII, The Making of Leather, J. A. Wilson; XIII, Nonferrous Metallurgy, H. W. Gillett; XIV, Chemistry of the Packinghouse Processes, W. D. Richardson; XV, Chemistry in the Pulp and Paper Industry; XVI, Perfumes and Flavors, S. Isermann; XVII, The Petroleum Industry, G. L. Wendt; XVIII, Photography, or Picture Making by Light, S. E. Sheppard; XIX, Synthetic Resins: A Chemical Contribution to Structural Materials, A. V. H. Morey; XX, Chemistry in the Rubber Industry, W. J. Kelly; XXI, Chemistry in the Textile Industry, L. A. Olney.

The outstanding article is "The Making of Leather." Others carrying particular appeal to the reviewer are those on Glass, Non-ferrous Metallurgy, Packinghouse Processes and Photography. But it is clearly impossible to arrange the chapters in even an approximate "electromotive series," for they are all good.

While many points of view are necessarily represented, the various authors consistently emphasize the value of the scientific attitude of mind, the necessity of chemical control of all products and processes in any successful industry and the sound investment represented by research. "The chemist always wants to know exactly what is happening in the process he is handling and never rests until he has at least a good working hypothesis." (Kelly, p. 347.) "The amateur chemist and eccentric inventor may contribute their bit, but any satisfactory process will finally be worked out in the usual

long painstaking way by a group of highly-trained scientific men, business men and engineers.... No one genius will discover it overnight." (Keyes, p. 36.)

The following paragraph illustrates the fine spirit of patriotism running through the book—"The young chemist must prepare himself to receive the torch of leadership....and by his science, art and skill, complete the process of making America as free from the chemical dominance of other nations as our forefathers made it independent of political and moral dominance." (Deemer, p. 117.)

The book has a tremendous appeal to the imagination. The present power of chemistry and its inevitably brilliant future are impressed on one at every turn. One field of research is likened to a "new and unexplored continent, of which we scarcely know the shoreline." (Speer, p. 73.) Law (p. 84) says "the ugly little cotton seed will be found comparable only to Alladin's lamp in the products which it will produce and the food for scientific research which it contains." According to Gillett (p. 198), "in all the advances of metallurgy, the chemist has done, is doing and will do most of the work. New inventions....even the names of which we do not know, will come. Chemists who will....acquire this new knowledge are now growing up, though they may not know they are going to be chemists....To any such chemists to be....the writer offers his congratulations, first, because their work will be a service to mankind and second, because they will have a mighty interesting job."

The many successful applications of chemistry, the achievements of famous chemists and the promise of future successes cannot fail to stimulate the interest and fire the imagination of the most casual reader.

R. A. BAKER

General Chemistry. HORACE G. DEMING. John Wiley & Sons, Inc., New York, 1923. xii + 605 pp. $3.50.

The author has made a special effort to give his book flexibility. "The purpose has been to encourage the instructor to teach what he wishes to teach, in the order that seems best to suit the past preparation and future needs of his students." The book may be used equally well by beginners and by students with previous knowledge of chemistry, as the arrangement of the material permits the employment of a somewhat different sequence of topics in the two cases. A feature of the book is the provision made—in the form of additional paragraphs and difficult exercises—for the student of superior ability.

The book is thoroughly up-to-date. The present viewpoint of the constitution of matter is introduced early and used throughout. There are chapters on the colloidal state, on nutrition, and on electrochemistry, in addition to those on the more important carbon compounds.

The author and the publishers have spared no pains in their effort to make the text of maximum value to the student. There are graphic summaries and exercises at the end of each chapter, and general review exercises at the end of the book. The appendix is very complete and includes a bibliography and a list of important events in the history of chemistry. The line-drawings and photographs are carefully selected and well executed. There are frequent hints and devices to warn the student of difficulties and to assist him in his study. There are few mechanical and typographical errors.

The book seems to be endowed with much of the freshness, enthusiasm and vision of its author. It may seem strange and different at the first reading to those who have already examined dozens of introductory texts, but interest deepens as the reader understands and enters into the spirit and purpose of the author. Certainly no teacher of college chemistry should fail to give this text his careful consideration.

H. H. LLOYD

Exercises in General Chemistry. HORACE G. DEMING assisted by SAUL B. ARENSON. John Wiley & Sons, Inc., New York. 1924.

This laboratory manual has been advanced "with the thought....that an elementary course in chemistry has....three chief aims:

1. To make the student familiar with a few representative types of matter.

2. To reveal some of the general principles that govern the transformations of matter.

3. To afford some experience with the experimental methods by which chemistry has won its advances."

The exercises are presented in an attractive form. There is first a general statement to make plain the purpose of the experiment. Then come the directions, including a list of materials needed. They frequently take the form of experimental problems. The questions to be answered by the student are grouped at the end. Each question refers by number to a designated part of the directions. Space is provided for writing the answers in the manual, if it is desired.

In accordance with the plan of the authors, the exercises in the first part of the book include descriptive and preparative work, and a number of quantitative experiments. A variety of laboratory procedures involves the use of a variety of apparatus. The last third of the work is given over to systematic qualitative analysis. This takes the place of purely descriptive, test-tube experiments on the metals.

In the opinion of the reviewer the authors have done an excellent piece of work in the preparation of their "Exercises." H. H. LLOYD